The Blast Furnace and Steel Plant

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Index to Contents

VOL. VII. JULY, 1919. No. 7

Page
DESCRIPTION OF AUTOMATIC ORE UNLOADER 317
HEATING FURNACES AND ANNEALING FURNACE—PART VII 321
BY W. TRINKS.
METHODS OF BLAST FURNACE CHARGING 325
BY HARRY S. BRAMAN.
ROLLING MILL ENGINE REPAIRED BY OXWELDING 327
BY L. M. MALCHER.
ANCHOR CHAIN HEAT TREATING FURNACES 329
BY T. F. BAILY.
HYDRAULIC VS. ELECTRIC AUXILIARY DRIVES 330
BY R. B. GERHARDT.
ELECTRICAL CLEANING OF BLAST FURNACE GAS 334
BY W. H. GELLERT.
CLAIRTON BY-PRODUCT COKE PLANT EQUIPMENT 340
BY FRANK F. MARQUARD.
ELECTRIC RESISTANCE HEAT TREATING FURNACE 343
BY A. M. CLARK.

Page
CONTINUOUS FURNACE FOR HEATING FORGINGS 346
PHOSPHORUS ESTIMATION IN HIGH SPEED STEEL 348
BY G. W. GRAY AND JAMES SMITH.
COMBUSTION CONTROL IN MILL BOILER PLANT 349
BY ROBERT JUNL.
SMALL TURBINE APPLICATION FOR STEEL MILLS 351
BY G. T. KEECH, JR.
FIRING BOILERS WITH POWDERED COAL 352
BY L. C. HARVEY.
FOREIGN RELATIONS 354
PRODUCTION TOPICS 356
NEWS OF THE PLANTS 357
SOME POINTERS ON BY-PRODUCT COKE OVEN OPERATIONS 358
OPEN HEARTH 359
INDUSTRIAL RELATIONS 361
WITH THE EQUIPMENT MANUFACTURERS 362
TRADE NOTES, TRADE PUBLICATIONS, SOCIETY MEETINGS 364

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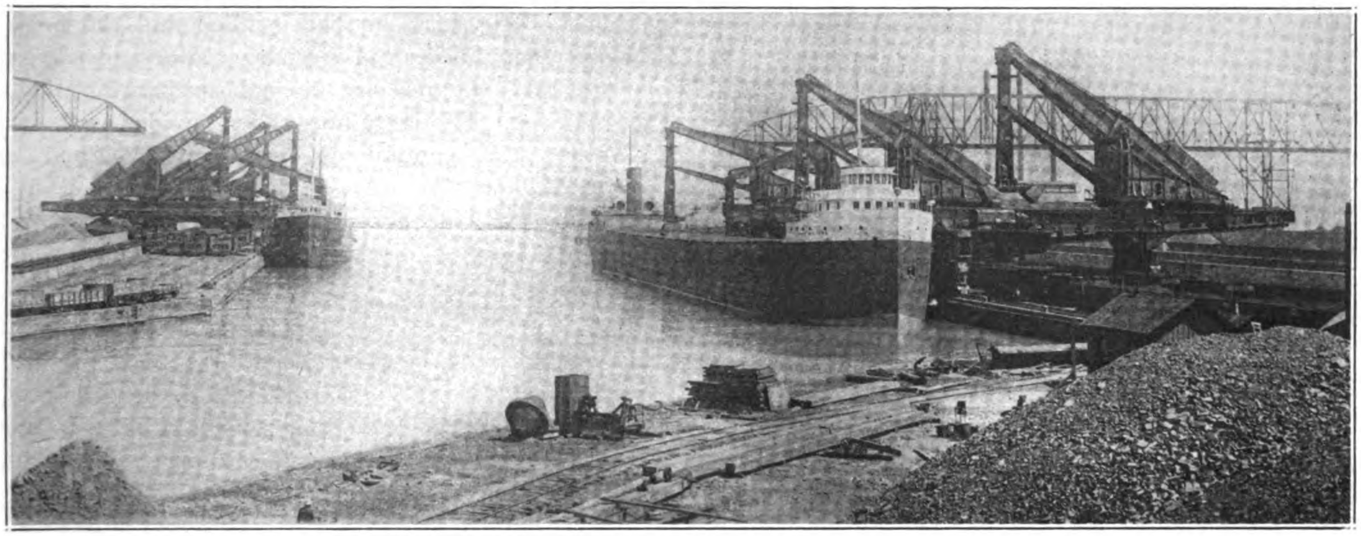


On the docks at Ashtabula are eight electrically operated W-S-M unloaders, each having a 15-ton bucket. The unloading capacity of these docks is 76,000 tons in 24 hours, the total cargoes of six of the largest ore-carrying vessels. Each machine is equipped with a suitable mechanism for accurately weighing the ore.

Description of Automatic Ore Unloader

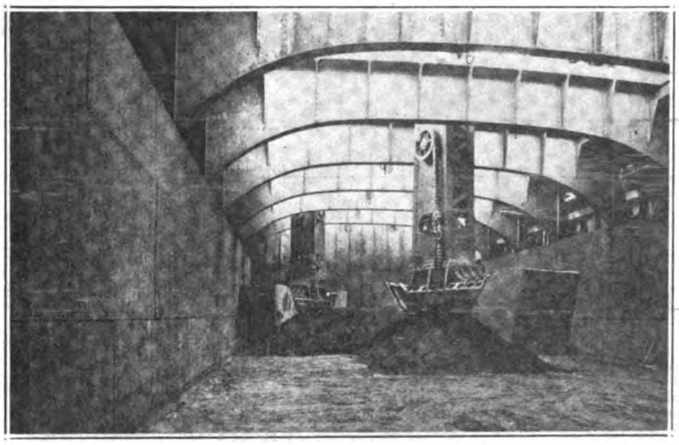
Design of Unloaders Simplified and Control Perfected—Large Tonnages Handled With Distinct Saving in First Cost as Well as Yearly Saving in Operating Claimed for This Type Machine.

The automatic unloader shown in the accompanying illustrations, is unique in design and has proved through many years of service to be one of the most successful devices for unloading ore cargoes from lake steamers that has ever been devised. Although of immense proportions, the design has been simplified and the control perfected to such a point that the machine is the last word in delicacy of control and operation.

The unloader consists of a main framework mounted on trucks which travel along the runway rails which are located approximately as shown in the photograph. The main framework extends back to the rear runway over a temporary storage pile where the ore can be discharged if desired. Between the front and rear runways, space is provided for railroad tracks where ore carrying cars are placed under the machines and loaded with ore for transportation to the furnace plants. The girders of the main framework form a support for runway rails, on which a trolley travels. This trolley supports a balanced walking beam, from the outer end of which a stiff bucket leg depends. At the lower end of this leg is the bucket, which is operated by machinery located on the walking beam. All horizontal movements of the bucket are accomplished by means of moving the trolley backward and forward on the girders. The vertical movements of the bucket are accomplished by the operation of the walking beam. The forward portion of the beam being out of balance, the bucket descends by gravity as soon as the brakes of the hoisting mechanism are released.

The hoisting mechanism controlling this operation is located in the enclosed house at the rear end of the walking beam. Ropes from the winding drums of this mechanism pass around sheaves located in the rear end of the trolley and are anchored to the rear end of the walking beam.

In addition to the main parts of the machine there is also a receiving hopper located at the forward end of the main framework and between the main girders, provided for the purpose of receiving the ore discharged from the bucket. The capacity of this hopper is about three full bucket loads and its purpose is to act as a balancing point for the ore between the bucket and the cars or storage as the case may be. The bottom of the hopper is provided with outlet gates and the contents discharged as required into a larry which runs on an auxiliary track suspended from the under side of the main girders.



Unloader leg and bucket at work in the hold of a modern boat are shown above. The leg is so mounted in the walking beam that it can rotate in a circle, allowing the bucket to reach out in all directions. These machines have often unloaded 97 per cent of a cargo without the help of shovelers. The distance from point to point of the bucket shell when open is 21 feet.

The larry, after receiving its load from the main hopper, moves to a point so that its contents can be discharged either into the cars standing on the railroad tracks beneath the main span of the girders or into a temporary storage pile under the cantilever at the rear of the machines. The ore so placed in this temporary stock pile cannot be reclaimed by means of these machines as their function is solely one of unloading the cargo from the ships.

Machines of this type have been made in two sizes, the smaller size having a capacity of 10 tons and the larger size (such as shown in the illustrations) having a capacity of 17 tons in the bucket shells. The machine shown here is electrically operated throughout and its speeds are regulated so as to operate through a complete cycle in about 50 seconds.

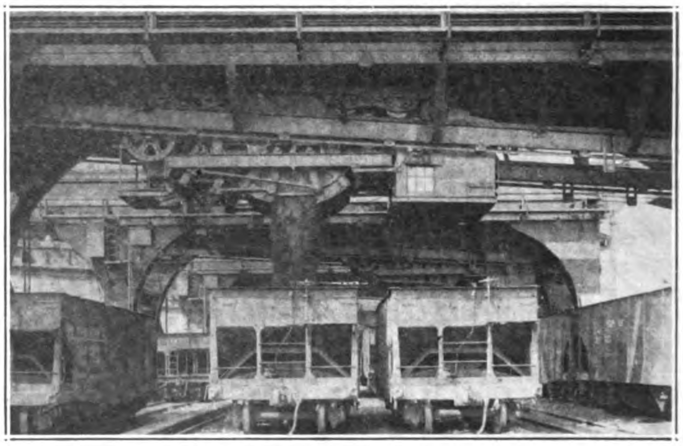
Some idea of the capacities of unloading by this method may be derived from a record which was made in Ashtabula by eight machines of this type having a capacity of 15 tons each, unloading seven boats having a total capacity of 70,000 tons in 22 hours actual time. At other points, four machines working in boats having capacities up to 13,000 tons have unloaded these cargoes in about 3 hours and 25 minutes.

The operation of the machine is as follows:

After the boat has been placed alongside of the dock, the machine is moved opposite one of the hatches and the bucket is lowered through the hatch into the ore. After filling the bucket, the walking beam hoist mechanism is put in operation and the bucket hoisted out of the boat. At the same time, the trolley is traveled back so that the bucket is brought over the main hopper between the girders in the main framework and its contents is discharged into this hopper. The bucket is then immediately returned to the boat for another load. The ore in the main hopper is discharged into the larry which has been brought to a point directly underneath the discharge gates of the hopper. The larry hopper is filled and the larry is moved over the desired discharge point and the gates of the larry hopper are opened discharging the ore as required. The larry hopper is provided with scales so that the content is accurately weighed and recorded. In this way, a car can be loaded to its allowable capacity and an accurate record kept of the amount of ore so discharged into the car thus eliminating the necessity for the use of track scales.

If railroad cars are not available for immediate shipment, the larry is traveled to a position on the rear cantilever and its contents discharged into a temporary storage pile, from which it is usually reclaimed for shipment or storage by means of a bridge, located on the runway at the rear of the unloader.

Only two operators are required for the entire operation of one of these machines. One of the operators, whose station is in the bucket leg directly over the bucket shells, controls all of the motions of raising and lowering the bucket, of traveling the trolley back and forth, and moving the machine along the dock from one hatch to another. The second operator is stationed in a cab on the larry and from this station he controls the movement of the larry, the operation of the larry gates, and the weighing of the ore.

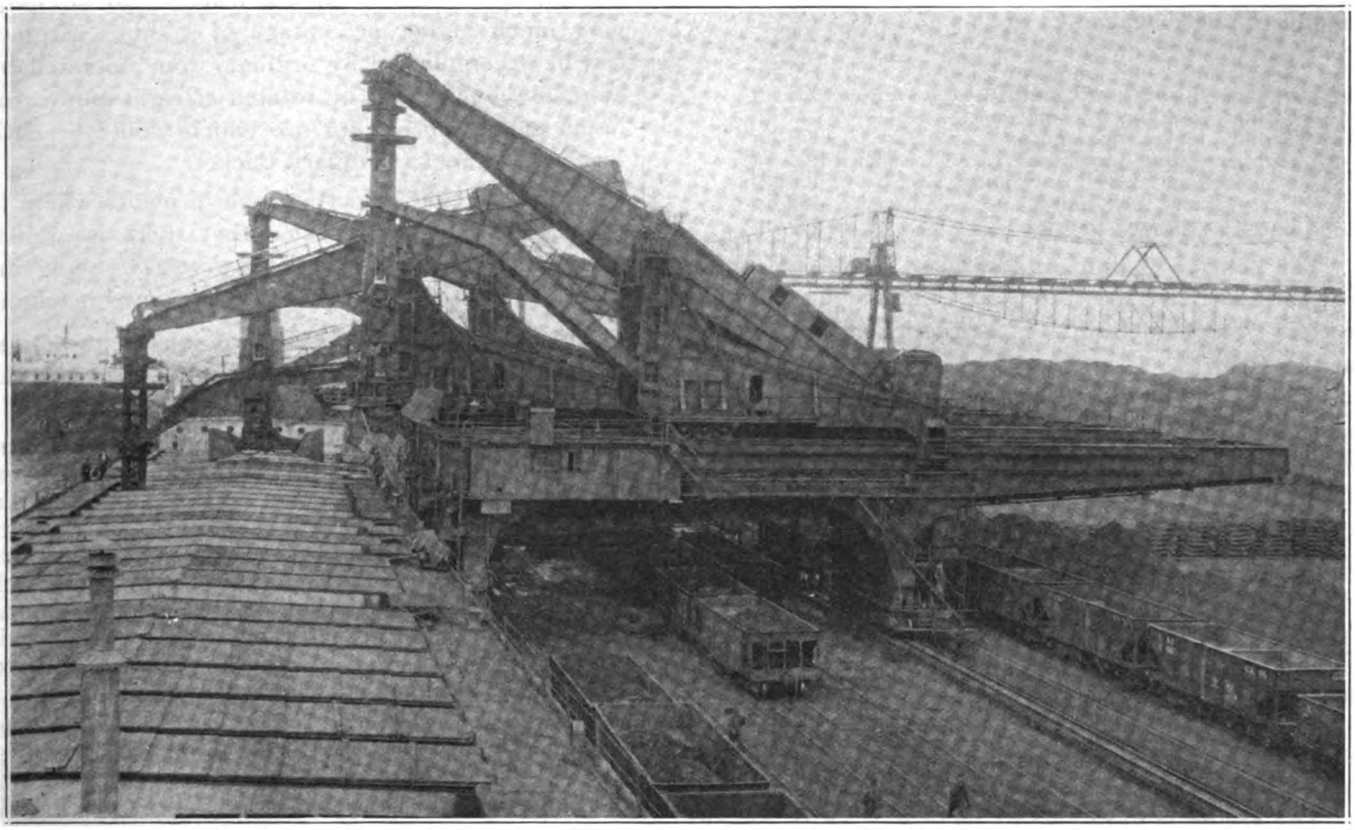


Scale larry, into which the main hopper discharges the ore. This larry accurately weighs the ore and discharges it into cars or into storage. Cars thus loaded are ready for shipment as they do not require reweighing.

The bucket shells are each made of a single piece of plate formed to the shape as shown in the illustrations. These bucket shells are usually provided with manganese steel cutting lips which are essential to resist the abrasive action of the ore. The bucket shells themselves are carried on heavy cast steel arms mounted on rollers traveling in guides in the fixed portion of the lower end of the bucket leg. The position of the operator who controls the operation of the bucket, etc., as previously described, is also shown on this photograph. The view shows the bucket in operation in the hold of a modern ore carrier after most of the ore has been removed and the balance of the order has been scraped into position so as to be handled by the bucket.

The motor for operating and closing of the bucket is located in the machinery house at the back of the walking beam. Ropes from this bucket closing mechanism are carried through the walking beam and the bucket leg and attached to a power drum in the bucket leg directly over the operator. This power drum is geared to the closing chain drums, one of which is shown on this photograph. The bucket is opened by reversing the motor and the bucket shells are forced open by means of an opening chain located in the center of the bucket leg between the two closing chains.

In addition to the vertical movement, which is given to the bucket leg by means of the walking beam, it also has a motion of rotation around its vertical axis. This is accomplished by means of ropes attached to a segment on the bucket leg itself, the ropes being carried back in the walking beam to a rotating mechanism which is located adjacent to the bucket closing mechanism. The bucket leg itself is carried on a roller bearing which is attached to the top end of the leg. This motion is introduced for the purpose of turning the bucket at right angles to the hatchway in order to secure as great a reach lengthwise of the boat as possible, thus the bucket is enabled to reach out under the hatches and remove ore which is not directly beneath the hatch opening. The distance from point to point of the bucket shells when open is approximately 21 feet.



At the docks of the United States Steel Corporation, Conneau O., there are seven Wellman-Seaver-Morgan unloaders, some of which are shown in the view above.

The scale larry, into which the main hopper discharges, has a capacity of between 35 and 45 tons and two larry loads are intended to constitute a full carload of ore. The arrangement of the discharge gates of the larry is clearly shown on this photograph. They are suspended from the sides of the larry frame and operated by connecting rods which attach to cranks, also connected to the main larry frame, these gates being operated by means of a small motor which is carried at the rear of the larry. The gates are so arranged that all or a portion of the contents of the larry may be discharged. The hopper of the larry is suspended in the larry frame on scales so that the contents of the larry may be wholly or partially discharged and be accurately recorded.

The mechanism for moving the larry back and forth on its track is also located on the larry and consists of winding drums upon which ropes are wound, the end of the rope being attached to the rear end of the cantilever on the main framework. The larry track is inclined and the larry is pulled up the incline by means of these ropes and descends by gravity.

As previously stated, these machines are usually electrically operated throughout. In some cases, however, machines of the same general type have been made to operate by steam and hydraulic cylinders, water being supplied to the operating cylinders by means of a steam accumulator which furnishes water at a pressure of 1,000 pounds per square inch. The electrically operated machines are usually designed for a 220 volt direct current. Alternating current is never used. The motors required for the equipment of one of these machines are as follows:

Beam hoist, one motor	275 hp
Bucket closing, one motor	120 hp
Bucket rotating, one motor	25 hp
Trolley travel, one motor	120 hp
Hopper gates, one motor	100 hp
Longitudinal travel, one motor	100 hp
Larry travel, one motor	150 hp
Larry gates, one motor	40 hp

The control equipment for these motors is of the magnetic switch type throughout, having master controllers in the operators' cabs in the bucket leg and on the larry.

Electric current is supplied to these machines by means of insulated conductor rails running the length of the main runways. The current is collected from these rails by means of pickup shoes and distributed to the various portions of the machine. A similar collecting device is also employed for supplying the main current to the trolley. Conductor rails are attached to the main framework of the machine and the current collected from these rails by means of pickup shoes attached to the trolley.

The points of superiority claimed for the Wellman-Seaver-Morgan ore unloader, which are not found in other systems of unloading are:

The design is very heavy; there is little to get out of order, resulting in low maintenance cost per ton of material handled.

The control is accurate and positive, and manual labor is reduced to a minimum.

The bucket is positively guided in passing through the hatches of ships, thus eliminating the danger of damage either to the boat or to the machines, arising from the use of rope suspended buckets.

The operator travels with the bucket into the boat, and can always see exactly what he is doing.

The bucket is of extremely large capacity, but is so suspended from the walking beam that the weight resting on the tank top of a boat is less than one-third of the weight of a rope suspended bucket of equal capacity. In fact, it is impracticable to use a rope operated bucket of anything like the size attained on these unloaders.

One particularly important point to be considered is the extremely low cost obtainable with these machines. Records extending over long periods show unloading cost ranging from 2½ to 4½ cents per ton, which includes superintendence, labor, repairs and materials on the machines, as well as the cost of power and light.

On account of the high capacity of these machines, the number of units required is less by a considerable margin than that of a smaller type lighter machine, which results immediately in a decreased cost of operation, for the reason that a fewer number of skilled operators is required.

Again, on account of the extreme reach of the bucket, it is possible for the machine to discharge a very much higher percentage of a ship's cargo than can be accomplished by ordinary rope operated buckets. The bucket can be rotated at right angles to the hatch and reach out for ore which would be entirely inaccessible to an ordinary bucket.

It can be conclusively shown in plants where large tonnages are to be handled that there is a distinct saving in first cost, as well as a yearly saving in the cost of operation, over any other type of machine.

EDITOR'S NOTE:—It may be of interest to note some of the remarks made by J. E. Johnson, Jr., with regard to the Hulett unloaders, as follows:

> The absolute control of the mechanism which the operator exercises by having it rigidly supported instead of swung, and by the fact that he himself is immediately above the bucket and can see to control its movements accurately, gives this machine advantages in handling bulk cargoes not enjoyed by any other type of machine. One of these advantages is that this accurate control of the grab bucket enables the operator to avoid striking the bottom of the hold severe blows with the bucket as frequently happens with older types of apparatus.
>
> In reclaiming the ore from the stock pile for use at the furnace the operation is very similar to that of stock piling. But in this case also it is necessary to provide some more easily moveable means than the bridge itself for carrying the ore from the bridge to the point of consumption. It will be readily understood that there are always several, and often very many varieties of ore in the stock pile, and on account of the great difficulty in keeping these separated, the same kinds of ore are always piled together, so as to make the individual piles as few in number and as large as possible.
>
> When any given kind of ore is desired for the furnace therefore, the ore bridge is moved over the pile and the grab bucket set to work on it. At the furnace or discharging end of the bridge it spans at least one and generally several tracks. Each traverses the tops of the bins from which the immediate supplies of raw materials are drawn. On one or more of these tracks runs a drop-bottom transfer car, generally driven by an electric motor under the control of its operator. Such a car can carry fifty or more tons of material a trip. The distance from the bridge to the bins where the ore is needed being only a few hundred feet, it can readily run back and forth from bridge to bins, and serve the bridge about as fast as the latter can reclaim the ore.

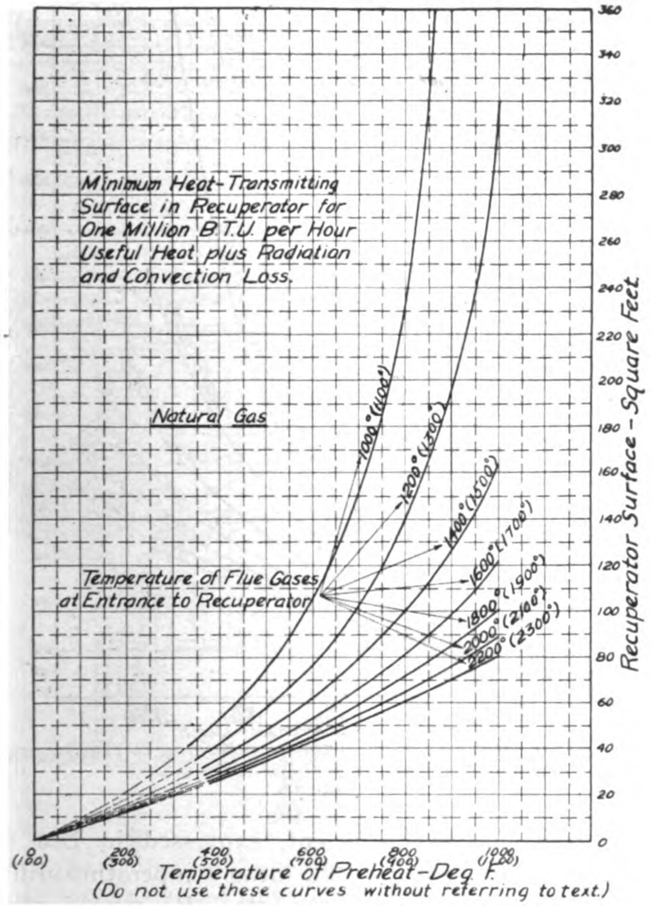
Heating Furnaces and Annealing Furnaces

Curve Sheets are Given from Which the Recuperator Surface Can Be Found Instantly for Any Recuperative Furnace—Conversion Factors are Derived for Adapting the Values to Conditions.

By **W. TRINKS.**

PART VII.

From the explanations in part 6 of this series it is evident that regenerators and recuperators, if properly arranged, can save great quantities of fuel. It is also evident that the calculation of the heat transmitting area required for a desired preheat offers some difficulties, and even if the difficulties are removed, is exceedingly tedious.



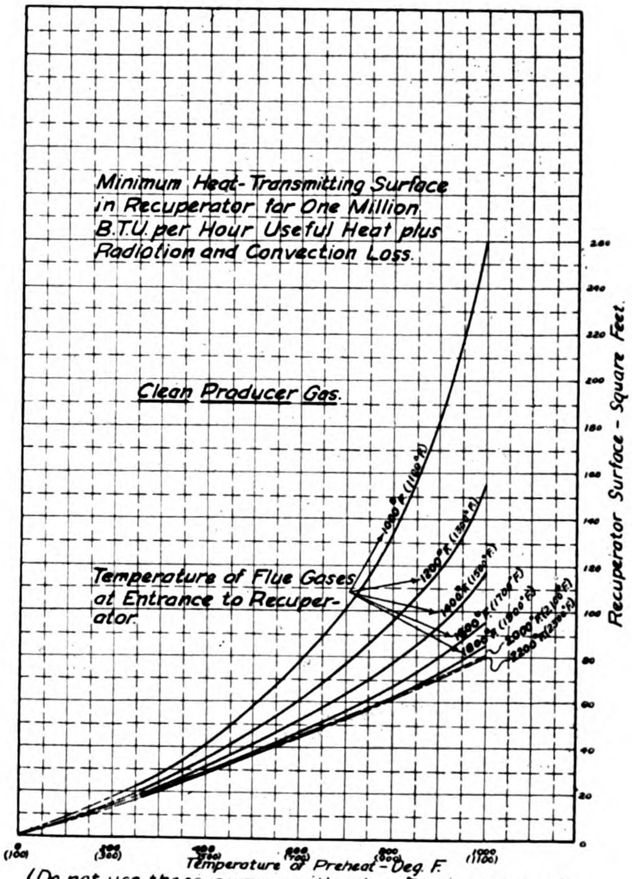
(Do not use these curves without referring to text.)

Fig. 46.

The purpose of the present installment is to remove not only the difficulties, but also the tedious part of the calculation.

To that end, use will be made of the data given in part 3 and in part 4 of this series, and curves will be calculated for different fuels, from which the necessary heat transmitting area of the recuperator can be read directly for a given furnace and for a desired preheat.

To calculate a given point on any one of the curves we must first know the amount of heat which is to be transmitted, and the temperature difference which drives the heat through the recuperator walls. The temperature difference in question is found from the temperature of the gases which enter the recuperator, from the temperature of the entering air, and from the desired temperature of preheat in the manner outlined in part 6 (June issue). The quantity of heat which is to be transmitted depends upon the heat requirements of the furnace, and upon the temperature of the flue gases, when they leave the furnace.



(Do not use these curves without referring to text.)

Fig. 47.

An example will make this statement clear. Take a furnace which required 1,000,000 Btu per hour to cover heat losses by transmission through the furnace walls and to cover heating of the material. (For the method of determining such heat requirements, see part 3). Let the flue gases leave that furnace at a temperature of 1,200 degrees F., and let it be desired to preheat the air to 600 degrees F. For the first calculation, the air will be assumed to enter at zero degrees F., and a correction factor will, later, be found for air entering at other temperatures. Let the fuel be natural gas. Then the heat of combustion per cu. ft. of natural gas is 1,015 Btu, while the heat in the preheated air necessary for burning one cu. ft. of natural gas equals 110 Btu. (See Fig. 27, part 4.) The heat brought into the furnace by the fuel mixture (1 cu. ft. of gas plus necessary air) then equals the sum, or 1,125 Btu, on the basis of perfect combustion. But the heat in the products of combustion of one cu. ft. of gas leaving the furnace with a temperature of 1,200 degrees F. equals 265 Btu, so that 860 Btu have been utilized per cu. ft. of gas. Hence,

$$\frac{1{,}000{,}000}{860} = 1{,}162 \text{ cu. ft. of gas required per hour.}$$

The heat to be transmitted through the recuperator walls per hour equals 110x1,162 or 127,820 Btu, because the air per cu. ft. of fuel gas gains 110 Btu.

In order to find the mean temperature difference, we must know the temperature of the flue gases when they leave the recuperator. It is determined by the heat abstraction in the recuperator, in this manner: The heat in the flue gases at 1,200 degrees F. equals 265 Btu. The air gains 110 Btu in the preheating. This heat must come from the flue gases so that they leave with 265-110 = 155 Btu. From the curve, Fig. 27, part 4, the corresponding temperature is found to be 725 degrees F. The average temperature difference then is ½ (1,200 — 600 + 725 — 0) = 663 degrees F.

The required surface then is found to be

$$\frac{110 \times 1{,}162}{2.5 \times 663} = 77 \text{ sq. ft., which value furnishes one}$$

point on the nest of curves in Fig. 46.

The meaning of the figures of this equation is clear with the possible exception of 2.5 which equals the heat transmission coefficient, expressed in Btu per sq. ft., hour, and degree F., mean temperature difference between flue gas and air. Reasons for the choice of this value were given in part 6. Since the time of writing part 6, I have made tests on heat transmission through recuperators at high temperatures and have found that 2.5 is indeed a very good value for heat transmission through metallic walls.*

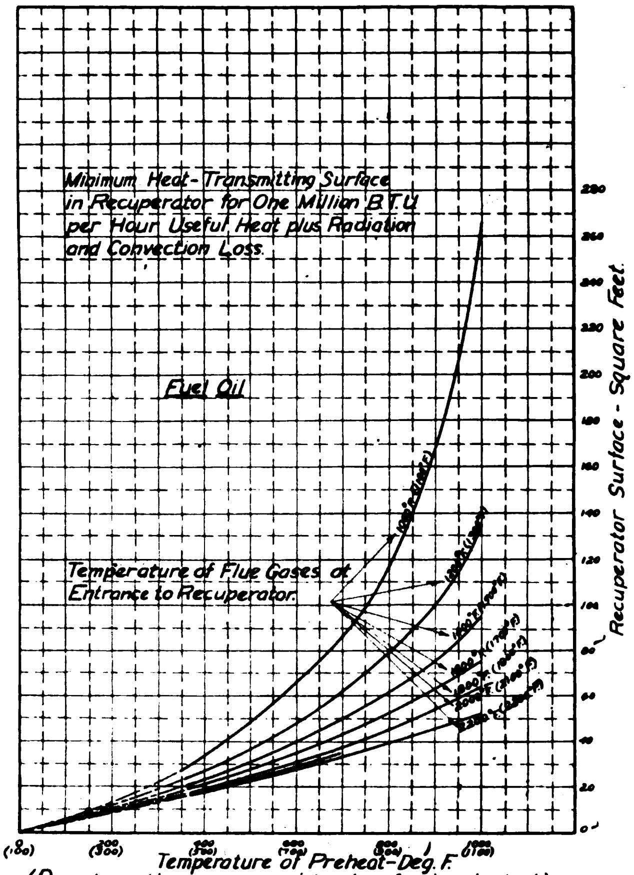


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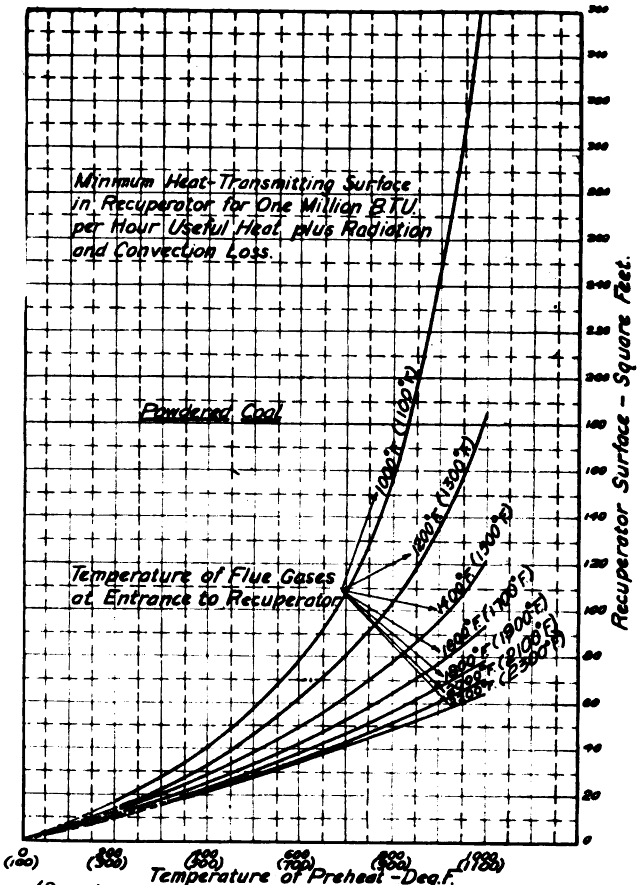
Fig. 48.



(Do not use these curves without referring to text.)

Fig. 49.

To get comparative values for cases where air enters the recuperator at temperatures above zero, the recuperator surface will be figured for temperature of preheat 600 degrees F., and furnace temperature 1,200 degrees F. as before, but with air entering at 100 degrees F.

---

*The tests which were made in transmitting from heated air to cooler air through a steel pipe showed the same curious result which had been observed by other experimenters: that it is more difficult to wipe heat onto a surface than it is to wipe it off. The important fact resulting from this condition is that the temperature of recuperator walls is lower than we would ordinarily expect.

Since final preheat temperature is the same as before, the quantity of gas required per 1,000,000 Btu radiation plus useful heat, remains also the same, or 1,162 cu. ft. per hour. Heat in the air leaving recuperator is 110 Btu, but the air enters the recuperator with 18 Btu. Hence, the heat transmitted in the recuperator is $(110 - 18) \times 1{,}162 = 106{,}900$ Btu per hour.

Flue gases leaving the recuperator have $265 - (110 - 18) = 173$ Btu. From Fig. 27, their temperature is 810 degrees F. Average temperature difference between gas and air is $\frac{1}{2}(1{,}200 + 810 - 600 - 100) = 655$ degrees F. Required surface $=$

$$\frac{(110 - 18) \times 1{,}162}{2.5 \times 655} = 65.2 \text{ sq. ft.}$$

Now by interpolating in Fig. 46 to get surface for 500 degrees preheat and 1,100 degrees furnace temperature, it will be found that the surface required is 64.7 sq. ft. From the close agreement of the two values, viz., 65.2 and 64.7, it is evident that the curves can be used for any temperature of entering air if the values of preheat and flue gas temperature are shifted by the difference between temperature of entering air and zero. The numbers enclosed in brackets, which have been added in Figs. 46 to 49, show the temperatures applying to the curves, when the entering air temperature is 100 degrees F.

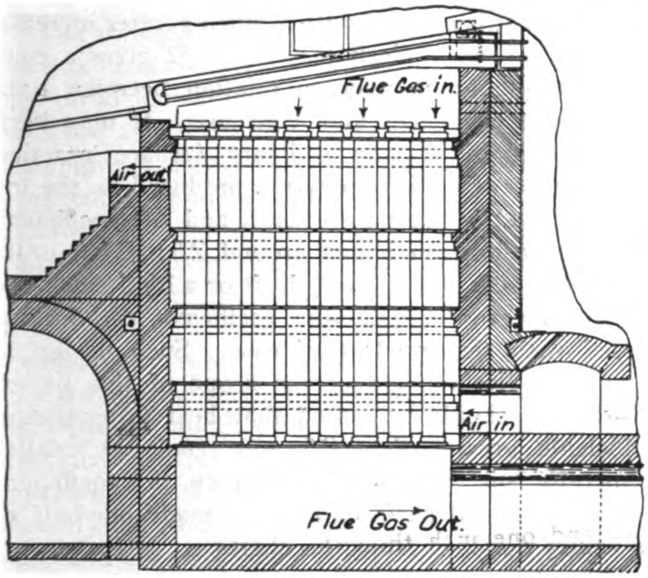


Fig. 50.

Figs. 47, 48 and 49 contain curves similar to those shown in Fig. 46. They give recuperator surfaces for different fuels. Like Fig. 46, they give the minimum recuperator surface for a furnace requiring 1,000,000 Btu per hour to cover furnace wall losses and useful heat in material being heated. If these heat requirements are "H" Btu per hour, multiply the surface values obtained from the curves by $\frac{H}{1{,}000{,}000}$.

In connection with the use of any of these curves the following precautions must be observed: The values of the recuperator surfaces are minimum values. In practice, larger surfaces must be provided, for several reasons, some of which were explained in part 6. Briefly, these reasons are: Some of the flue gas escapes around the door; there is radiation from the outer surface of the recuperator; combustion is not perfect; there is leakage of preheated air between recuperator and burner; true counter current conditions do not exist. Everyone of these departures from ideal conditions lowers the preheat obtained with a given surface, or, put the other way around, requires a greater surface for a desired preheat than would be the case with ideal conditions.

It is almost impossible to give general values for the additional recuperator surface required over and above the ideal value found from the curve sheet, except by careful weighing of the conditions surrounding each individual case. With poor design, poor operation, and otherwise unfavorable conditions the ideal surface may have to be trebled. With average condition, 25 to 30 per cent excess area will form a good safety margin.

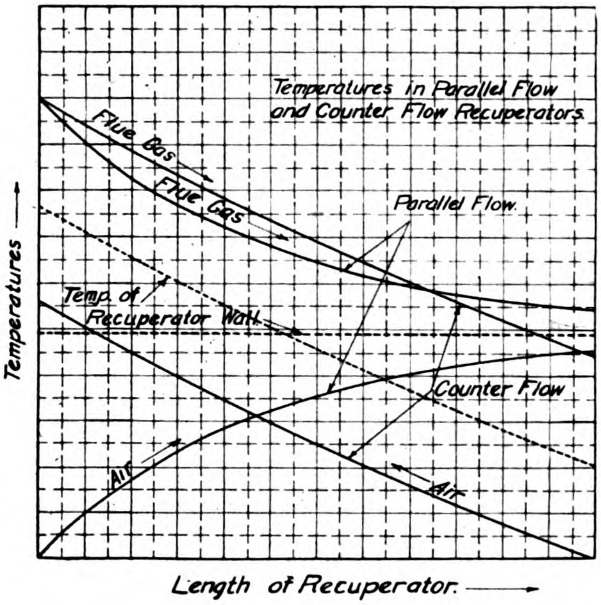


Fig. 51.

Going back to the statement made two paragraphs above, namely, that true counter-flow conditions may not exist, we must be conscious of the fact that the curves of recuperator surface were plotted from calculations which are based upon the average temperature difference of true counter-flow. In many recuperators counter-flow is aimed at, but not wholly materialized. An example of such a design is shown in Fig. 50. Although baffles have been provided, there are dead corners which transmit very little heat. Furthermore, the temperature distribution through the recuperator is rather complex so that the mean temperature difference varies from tube to tube. In spite of this condition the values given in the curves may be used, unless a very high preheat is desired. From Fig. 51 it is quite clear that with counter-flow, the air can be preheated almost up to the temperature of the flue gas, while, with parallel flow the highest possible temperature of preheat is quite low.

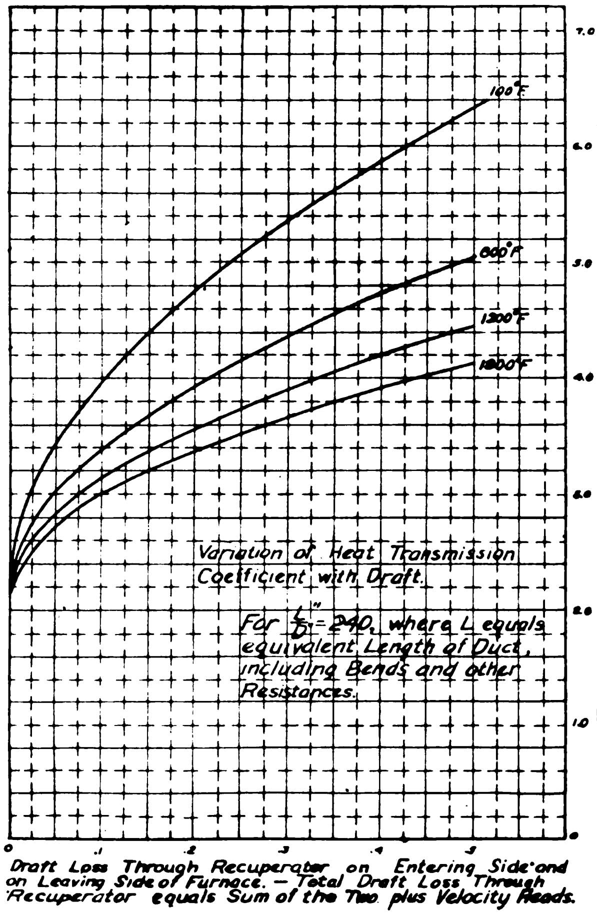


Fig. 52.

It may be remarked here that recuperators are frequently built on the parallel flow principle for the purpose of keeping the heat transmitting surfaces from being burnt out. The dotted lines in Fig. 51 represent temperatures of recuperator wall. It will be seen that the wall temperature is constant in the case of parallel flow, while it is variable in the case of counter-flow. It will also be noticed that the highest wall temperature in the latter case exceeds the constant wall temperature of the parallel flow arrangement. This feature will be discussed in detail later under the heading of critical comparison of furnace designs.

Figs. 48 and 49 show recuperator surfaces for oil and for powdered coal. Both of these curves have one feature in common, namely, that they were laid out for preheating part of the combustion air only. In oil burning as well as in the burning of powdered coal it is customary to use part of the air for atomization or scattering, and not to preheat that part of the air. The amount so used varies with different burners, so that the curve sheets cannot be right for all of them; however, they are right for average conditions. The curves for oil were based on 30 per cent of the total air being used for atomization, while the curves for coal were based on 20 per cent of the air being introduced with the coal. If different percentages are used, corrections can easily be made with a fair degree of accuracy.

A few words need be added about increasing the heat transmission coefficient and thereby reducing the required recuperator surface. In part 6, mention was made of the general laws of heat transmission, and it was pointed out that high velocities, and long paths of the heat exchanging fluids result in wonderful increase of the heat transmission coefficient. But it was also pointed out that the increase of heat transmission coefficient is coupled with a much greater increase of pressure drop, or draft loss. Fig. 52 gives a concrete example of an average relation between heat transmission coefficient and draft loss. It may here be stated again that in ordinary furnace practice natural draft, or a slight pressure produced by the injection of fuel or steam, are used, and the coefficient of heat transmission hangs around 2.5; if fan draft on the inlet side and induced draft or a high stack are used on the outlet side, the coefficient can be increased with the greatest of ease. Such design is special and lies outside of the scope of this paper. However, it should be stated that heat transmission coefficients greater than 2.5 will result in smaller recuperator surfaces. If, for instance, the coefficient equals 5, then all surfaces may be made one-half of the values obtained from the charts.

Finally, it must be stated that the values of the curves are correct only for metallic recuperators. If recuperators of refractory material are used, the overall heat transmission coefficient is very much lower. Consider, for instance, a firebrick tile, 2 inches thick to be the heat transmitting partition. The conductivity of firebrick is 9 Btu per hour, degree F., sq. ft., and one inch thickness. The total resistance which, for a metallic surface was equal to $\frac{1}{4} + 1/6.7 = .40$, now rises to $\frac{1}{4} + 1/6.7 + 2/9 = .62$. In consequence, the heat transmission coefficient drops from 2.5 down to $\frac{1}{0.62}$ which equals 1.62. The ratio of 2.5 to 1.62 equals 1.55. For the case in question, the recuperator surfaces taken from the curves would have to be increased 55 per cent, in addition to the increase which is caused by departure from ideal conditions.

Methods of Blast Furnace Charging

Discussion of J. A. Mohr's Paper Read Before American Iron and Steel Institute—Description of Blast Furnace Practice at the Youngstown Sheet & Tube Company.

By HARRY S BRAMAN,
Supt. Blast Furnaces and Steel Department, Youngstown Sheet & Tube Co.

Mr. Mohr's paper on the "Method of Charging Raw Materials in the Blast Furnaces," is a comprehensive account of the different systems used in handling air, coke, limestone and ore, and should be of vital interest to every blast furnace man. Nothing in the practical operation of blast furnaces can cause so much continued inefficiency as their improper handling. In endeavoring to review some of the points brought out in Mr. Mohr's paper (June issue), I have taken the liberty of describing their application to the Youngstown Sheet & Tube Co.

Method of Charging Air.

The air supply of our four furnaces at East Youngstown is furnished by four horizontal Tod engines and one turbo blower. As the outside air is freer from moisture and other impurities than the air found in the engine house, the intake was placed outside. Until recently the air intake was a general intake for all furnaces. However, we noticed with this arrangement that the engine on the end of the line was apparently receiving under the same conditions a better supply of air. In other words, the engine nearest the intake seemed to be robbed of its full air supply. A series of experiments were conducted to determine what discrepancies might exist. These experiments plainly indicated that our No. 1 furnace engine was receiving approximately 7 per cent more air than the engine nearest the intake. We give below our actual tonnage and coke consumption on No. 1 and No. 3 furnaces, operating under almost identical conditions for a period of six months. These results seem to verify the experiments and we have accordingly made arrangements to have a separate intake for each engine.

	No. 1 Furnace.		No. 3 Furnace.	
	Average daily tonnage	Average coke per ton of metal	Average daily tonnage	Average coke per ton of metal
November	584	1999	555	1951
December	607	1976	572	1983
January	594	1925	542	1959
February	589	1839	557	1955
March	609	1696	544	1866
April	571	1816	524	1882
Average	592	1875	549	1933

Bins—Ore, Flux and Fuel.

The Hoover-Mason bin system for the handling of stock has proven very satisfactory. In this system, the coke, ore, limestone and other miscelloneous material are all handled through the larry cars and dumped into a single revolving bucket, which in turn carries the material to the top for further distribution. Since accuracy in weight of materials is absolutely essential, we have welded the rails underneath the larry car so as to give very little chance for any variation caused by irregularities in the track. The cars are also equipped with tapes which record the weights of the different materials as they are being drawn into the car. These tapes are taken off each morning and carefully checked.

Although all of our coke is handled through our larry cars and their weights recorded, we much prefer the volume system, and accordingly fill the car level full regardless of the weight. There are good arguments on both sides of this question, but our results have been so much more satisfactory with the volume system that we prefer its adoption. The coke for all furnaces is made in our Koppers ovens and transported direct to the furnace by a high line road which delivers it to the bins in transfer cars.

The weighing of ore for each charge to the blast furnace is also an important operation. We have adopted and used generally at our furnaces a system by which each load of ore is identical in weight. There is less chance for error in weighing large quantities than in weighing small percentages in one charge. The table below illustrates our charging blackboard. This system can be used for any number of ores and percentages, ranging from 5 per cent to 100 per cent. in multiples of five.

	1	2	3	4	5
20 per cent of No. 1 ore............	1	..	1	..	..
30 per cent of No. 2 ore............	1	..	..	1	1
10 per cent of No. 3 ore............		1	..	..	..
40 per cent of No. 4 ore............	..	1	1	1	1

Our charge is as follows: Ore charge, 30,000 pounds. Coke charge, 14,000 pounds. Stone charge, 6,000 pounds.

In our method of filling, we use two buckets of ore, two buckets of coke, and one bucket of limestone, which includes each round, and five of these rounds comprises one grand round, thus giving a uniform mixture of the different percentages. The advantages in this method are many over the old method of weighing each ore in each round, particularly:

First—More accurate weighing due to a larger amount of ore, which will not be affected so materially by slight error in scales.

Second—Fewer trips necessary, less power required, and less wear and tear on the machinery due to fewer stops and starts.

Third—Speed in filling.

Distributing Machinery on the Furnace Top.

The dumping of the bell also enters into the careful operation of furnaces, and we find by alternating the periods of lowering that good results are obtainable. Following is the method of lowering the bell:

First coke First ore	Dump bell
Second coke Second ore and limestone	Dump bell

Two complete charges are filled as above and the third charge as follows:

First coke First ore	Dump bell
Second coke Second ore Limestone	Dump bell

This mode of filling is kept up for a few weeks, at the end of which the furnace may act lazy and seem to lag behind, not taking the number of charges it should.

At this point we change the filling as follows, which seems to give the furnace renewed activity.

First coke Second coke	Dump bell
First ore Second ore Limestone	Dump bell

This method was arrived at after several months experimenting with the various charges. We noticed that each new change seemed to be better than the one previously used, so the conclusion was drawn that a change in charging at regular intervals gave better operations than any fixed method, probably due to the fact that each new charging gave different paths of resistance to the gas, which resulted in cleaning the furnace, so to speak, and allowing freer working conditions.

The Neeland top which was incorporated in the design of our furnaces, has given us excellent distribution. We have, however, made a few minor changes in the original design and feel that by so doing we have increased the efficiency to some small degree. Just recently we have blown in No. 2 furnace which has been down for relining, and prior to our lighting up, a careful inspection was made of the stock as it lay on the top ready to descend for the process of reduction. Coarse and fine materials were evenly spread about and very little variation in the levels of the stock was noticeable. Barring furnace irregularities which might occur, we feel that the stock placed evenly on the top should descend intact and make for better furnace operation. The water-cooled wearing plates which are in use, are such that they remain unaltered throughout the life of a furnace and are something which can be absolutely depended upon. At times we have lost the water on individual plates due to a crack in the casting near the bottom, but this condition will not necessarily destroy the usefulness of the plate. It does, however, limit the amount of cooling effect according to its proportion of the entire circle. These plates have been used continuously for the past 10 years. They are made of cast iron with a pipe coil cast in and are about 6′ 8″ long, 2′ 11″ wide, 16 of which form the complete circle. Examination of two of our furnaces which have been in steady blast for four years and already have a total production of 864,395 tons, (daily average 562.7 tons) and 851,988 tons, (daily average 547.9) respectively, show that the stock is still being distributed in a satisfactory manner.

As mentioned before in this article, I have confined myself to our local practice, but have done so with the idea that most every one is interested in what the other fellow is doing, and by comparison of results we all derive benefits. Mr. Mohr has said many interesting things in his discussion and brought forth much food for thought, which I believe adds to the progressiveness of the business.

Editor's Note—R. W. H. Atcherson, blast furnace superintendent of the Inland Steel Company, Indiana Harbor, in discussing Mr. Mohr's paper made the following remarks which are of interest:

Remarkable blast furnace results have been attained on stationary top furnaces proving satisfactory distribution for the grade of raw materials used. If their raw materials had been of less excellent quality the need for rotating the top might easily have become a serious factor. The rotating tops have given excellent results on the Inland Steel Company's blast furnaces. During the present business depression No. 2 furnace was blown out after producing 1,041,970 tons of iron at a daily average of 525 tons and coke practice of 1,881 pounds. This is not claimed to be a phenomenal record, but we were surprised to find that the hearth, bosh and practically all of the stack lining had been worn back very uniformly about five inches.

I would like to add to Mr. Mohr's testimony that I have seen mixed filling substituted for stratified filling at a number of blast furnace plants using Mesaba ores, with beneficial results in every instance. The gaseous current or indirect reducing agent of the furnace physically as well as chemically seeks the particle of ore which it is destined to reduce and it is only by the proper mechanical preparation of the charge that the intimacy of contact is afforded to produce the most efficient blast furnace practice.

Rolling Mill Engine Repaired by Oxwelding

Low Pressure Steam Cylinder Fracture on Twin Tandem Compound Reversing Engine at the Farrell Works of Carnegie Steel Company Repaired in Record Time, Avoiding Long Shutdown.

By L. M. MALCHER.
Superintendent of Welding Shop, Oxweld Acetylene Company, Chicago, Ill.

One of the big steel rolling mill engines at the Farrell Works of the Carnegie Steel Company, Farrell, Pa., that had been doing its full share in helping to win the war broke down two weeks after the signing of the armistice, having worked constantly up to then on 100 per cent war orders. In the accident, besides other parts, the lefthand low pressure steam cylinder, 70 inches inside diameter, of an Allis-Chalmers twin tandem compound reversing engine was badly fractured, as a result of the breaking of a connecting rod at the moment of reversal.

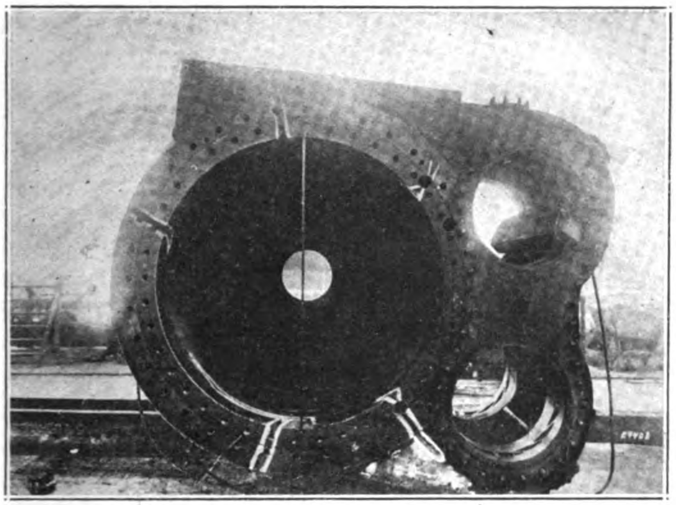


Fig. 1—Wrecked low pressure cylinder, showing cracks V-grooved by chipping preparatory to oxwelding. The seven cracks, all at head end, ranged from 1 to 8 feet in length and 2¼ to 3⅜ inches in depth.

A serious situation confronted the officials of the Carnegie Steel Company, as it would have taken at least three to three and one-half months to obtain a new cylinder, in case the broken one could not be repaired in a shorter time. Three hundred and sixty men were thrown out of employment. The broken cylinder was of such size and the damage done was of such a character that a decision whether the cylinder was to be renewed or repaired involved risk on the part of the management. Although considerations of expense as between the cost of purchasing a new cylinder and repairing the old one were of secondary importance, the cost of repairing was estimated to be about one third that of a new cylinder.

The officials of the Carnegie Steel Company, after careful investigation, quickly decided in favor of oxy-acetylene welding. They called upon the job welding shop of the Oxweld Acetylene Company, Chicago, Ill., to meet the emergency. Three expert welders, accompanied by all necessary equipment, went immediately to Farrell and completed the job under the direction of the writer. The total time consumed in repairing the low pressure cylinder, including chipping, preheating and welding, was 72 hours. While dismantling the engine a fracture was discovered in the right hand, 42 inches diameter, high pressure cylinder. This fracture also was repaired in about 18 hours. It took just seven days, from the time the order was given to the Oxweld Acetylene Company to complete the entire job.

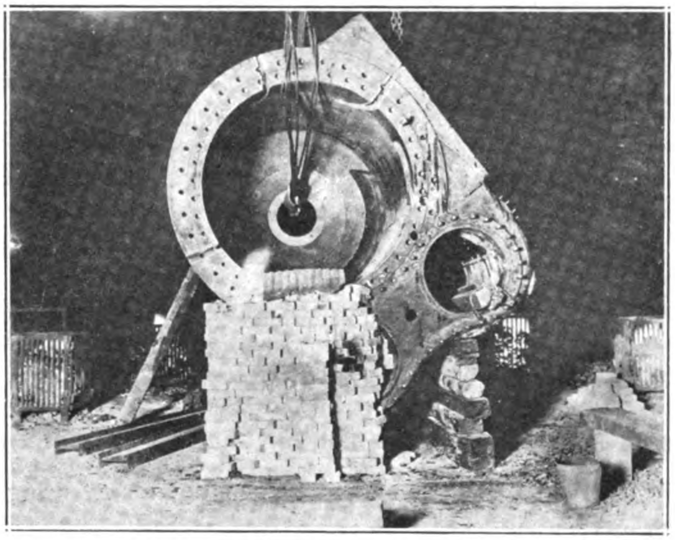


Fig. 2—Preheating crack in low pressure cylinder by means of charcoal fire. Castings handled by crane.

The data covering this work are given in detail below:

Low Pressure Steam Cylinder.

5,000 hp Allis-Chalmers twin compound reversing engine. The H. P. given is maximum power developed while rolling and running at about 100 to 110 rpm.

Cylinder bore, 5 ft. 10 in.

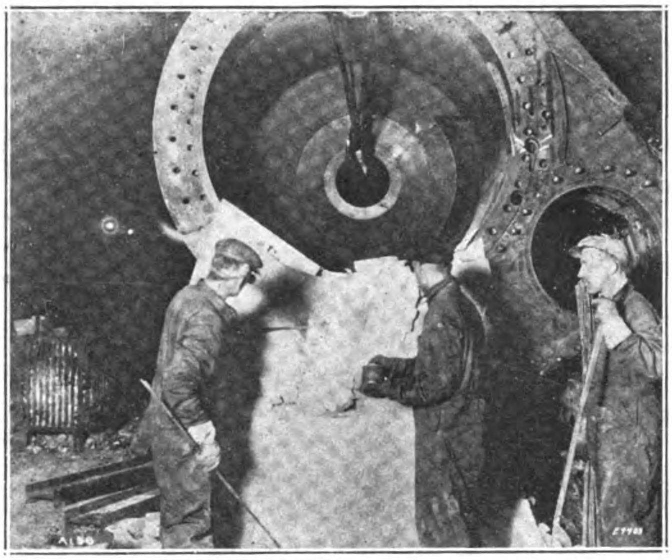


Fig. 3—**Welding the low pressure cylinder. Asbestos paper used to protect workers and retain heat from preheating fire. Extra long blowpipes and rods required for the long cracks.**

Stroke, 4 ft. 6 in.
Weight of cylinder, 13 tons.
Thickness of iron casting, 2¾ to 3⅜ in.
Number of cracks (See Fig. 1), 7.
Total length of all cracks, 22 ft. 2 in.
Preparing and preheating casting, 27 hours.
Welding casting, 45 hours.
Linde oxygen consumed, 2,850 cu. ft.
Pres-O-Lite acetylene consumed, 2,845 cu. ft.
Oxweld cast iron welding rods, 390 pounds.
Oxweld "Ferro" flux, 25 pounds.
Number of welders, 3.
Period of welding shifts, 10 and 30 minutes.

High Pressure Steam Cylinder.

5,000 hp Allis-Chalmers twin compound reversing engine.

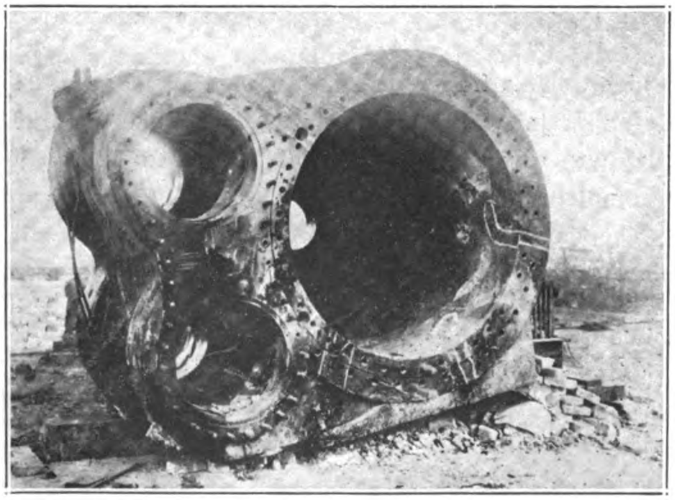


Fig. 4—Welding of low pressure cylinder completed.

Cylinder bore, 3 ft. 6 in.
Stroke, 4 ft. 6 in.
Weight of cylinder, 5 tons.
Thickness of iron casting, 3½ to 6 in.
Piece of flange broken off (See Fig. 5).
Total length of weld, 4 ft. 6 in.
Preparing and preheating casting, 9½ hours.
Welding casting, 8½ hours.
Linde oxygen consumed, 650 cu. ft.
Prest-O-Lite acetylene consumed, 650 cu. ft.
Oxweld ¼ in. cast iron welding rods, 110 pounds.
Oxweld "Ferro" flux, 10 pounds.
Number of welders, 3.
Period of welding shifts, 10 and 30 minutes.

While welding inside of the cylinder castings the men relieved one another every 10 minutes because of the heat deflected back on them during the welding operation. On the outside welding, however, the heat was not so intense and the men relieved one another every 30 minutes.

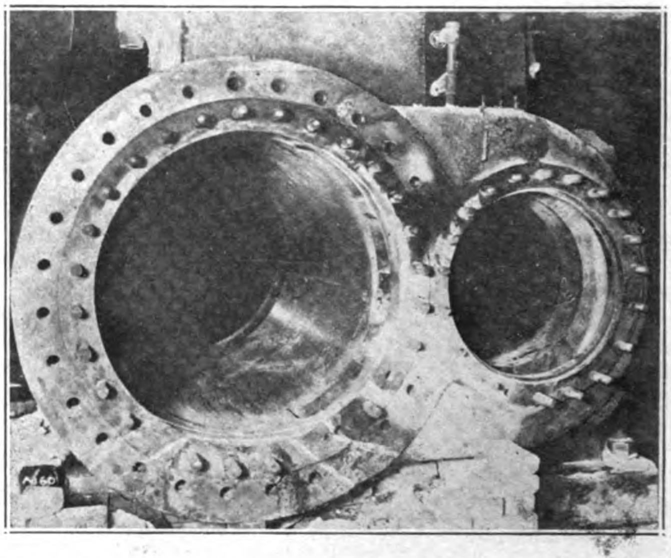


Fig. 5—**Flange welded on 5-ton high pressure cylinder. Weld 4½ feet long, 3½ to 6 inches deep.**

After the engine cylinders were machined, it was almost impossible to determine where the cracks occurred. The total cost of this repair represents but a small fraction of the replacement cost but even this saving is insignificant when compared with the disorganization which would have resulted from laying off a large body of trained workmen and with the enormous loss that would have been entailed in a stoppage of production.

Anchor Chain Heat Treating Furnaces

Description of Furnace for Treating Anchor Chain—Heat Treating Rails in Electric Furnaces Suggested—Summation of Points in Favor of This Type of Furnace.

By T. F. BAILY,
President of the Electric Furnace Company, Alliance, O.

The first installment of this paper appeared in the June issue of THE BLAST FURNACE AND STEEL PLANT. This installment deals chiefly with the description of an anchor chain heat treating furnace and summarizes the chief issues of the electric furnaces described in this paper.

A heat treating equipment for the heat treatment of cast steel anchor chain, with modifications as to handling mechanism is installed at the plant of the National Malleable Castings Company, Cleveland, O. This consists of a 600 kw hardening furnace, approximately 28′ long by 16′ wide, and a hearth the full length of the furnace and 6′ 6″ wide. At the discharge end of this furnace is located a concrete quenching tank, 40′ long by 8′ wide for quenching the chain. At the other end of this pit is a furnace of similar size, but of 300 kw capacity for drawing the temperature of the chain after quenching. Each of these equipments has a rated capacity of 50 tons of chain per day, and the current consumption when operating at capacity is substantially 450 kwh per ton, this current consumption being 150 kwh per ton higher than in the other heat-treating furnace just described and than the two similar sets at the same company's Sharon plant, due to the fact that the material is such that a larger furnace chamber was required for a given capacity.

The charge of material consists of two 90 foot lengths of two inch cast steel anchor chain, folded into loops 22′ long. These loops are dropped over heavy cast steel hooks, the end of which, when the charge is in the furnace, protrude through recesses cut in the furnace door. The ends of these hooks are connected to a heavy steel cross bar, which is provided with lugs for fastening on the pulling chains, operated by a heavy winch, similar to a crane drum, and equipped with a 20 hp motor. One of these winches is located 30′ beyond the discharge end of the drawing furnace, the other directly over the quenching pit.

The operation of heat treating these chains begins by dropping the loops of the folded chain over the hooks in front of the charging end of the hardening furnace, the hearth of the furnace being level with the foundry floor. The pulling chains are dragged through the hardening furnace from the front end by means of a light iron bar, the winding drum backing off the chain as it is pulled through. These chains are now hooked onto the steel cross bar of the cast steel hooks just mentioned, the winch reversed and the chain pulled into the hardening furnace, where it remains for substantially two hours, during which time it is fully and entirely heated to the furnace temperature, which is about 1,650 degrees F. The doors of the hardening furnace are then opened, and the winch pulls the chain out of the furnace into the quenching pit, where it lies on a steel frame work, composed of 7 inch channels. As the chain is immersed into the quench, it is met by a strong flow of fresh water from submerged nozzles, so as to give it an initial chilling, directly as it is immersed. As the tail ends of these chains pass out of the furnace door, the door closes, and the chain is allowed to lie in the quench for several minutes. Before it is completely cooled, however, the chains from the winch of the second furnace are dragged through that furnace and hooked into the cross member and hooks holding the chain in the quench. The pulling chains from the first furnace are disconnected, the doors of the second furnace are opened and the winch of the second furnace pulls the chain into the drawing furnace, where it remains for another two hours, and is subsequently and in a similar manner withdrawn from that furnace.

Large heat-treating furnaces of the automatic type such as are described in this paper, whose certainty of operation and precision of treatment have been clearly observed over several years, justify the consideration of the heat treatment of large tonnages of heavy material, such as steel rails. The building of equipments for such purposes presents no serious difficulty.

It is readily apparent to anyone interested in this subject that the heat treatment of rails is highly desirable, as the increased physical properties readily obtainable by a proper heat treatment are such as to very remarkably increase their efficiency, if not only adding to the life from the standpoint of wear, but adding materially to the ultimate strength and the elastic limit, without appreciably sacrificing the ductility or toughness; and the only real question that can be raised is whether successful heat-treating equipments can be found wherein every rail treated

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Final installment of paper read by author before May meeting of the American Iron and Steel Institute.

will have exactly the heat treatment specified, and whether such equipments can be rugged enough to operate with precision over long periods of time, and the cost of operation come within a reasonable commercial range.

The furnaces described in this paper, especially those of the automatic type, which have records of years of successful service, I believe fully answer the question as to precision and reliability.

As to the special requirements of an equipment for the handling of rails, this will require, of course, a rugged quenching mechanism that will prevent a 33 foot rail section from twisting during the quenching, and perhaps a similar mechanism after the drawing operation.

Such an equipment will have the advantage of complete elimination of the gag press operation.

As to the commercial cost of the heat-treating operation, as compared with the increased physical properties, it may be stated that the actual cost for electric heat under the conditions named in this paper would not exceed $1.50 per ton, and the labor cost would probably be no more, and perhaps less, than is now required in the straightening press operation above referred to. The ultimate strength of the rail would in all probability be increased more than 25 per cent, and the elastic limit perhaps doubled, while the life of the rail from a wearing standpoint would undoubtedly be materially increased. I believe it is a conservative statement to say that a 25 to 50 per cent more effective rail from a wear and safety standpoint could thus be obtained at an additional cost per ton of not to exceed 5 per cent.

The equipments described in the latter part of this paper are the forerunners of electric furnaces of the type that will soon come into regular use for operations on a far greater scale than will generally be conceded by the average steel maker today, and will embrace the wide and almost exclusive use of certain types, such as the soaking pit and certain forms of the reheating furnace first mentioned in this paper. While in some cases there will be an actual reduction in cost of operation over present methods due to the electric furnace, even for steel of average quality, the more rigid requirements in finished product will in some cases compel the use of electric furnaces.

Where requirements of the steel specified must be met, a lower cost may readily be found when operating electric furnaces, when taking into consideration the difference between the cost per ton of material put through the furnace, as compared with the cost per ton of material meeting the specifications.

Many of the arguments used against the introduction of electric furnaces were used against the introduction of large motors in the steel mills, and against electric haulage, and the statements frequently made through all the years about any innovation that "it has not been done and it cannot be done" must gradually yield, as one by one the various types of electric furnaces from heat-treating equipments to soaking pits go into regular, commercial and economical service

Hydraulic vs Electric Auxiliary Drives

Comparison of First Cost and Maintenance of Hydraulic and Electric Drives for Furnace Door Hoist, Furnace Cover, Side Guard Manipulator, Lifting Table and Middle Roll Balance and Shears.

By R. B. GERHARDT,
Superintendent Electrical Dept., Bethlehem Steel Company, Maryland Plant.

Since the electric motor has been applied to some considerable extent to steel mill auxiliaries, such as furnace door hoists and furnace covers, elevators, manipulators, lifting tables, middle roll balance and shears, there has arisen in the minds of a great many of the steel mill engineers, including some electrical men, the question as to whether or not this electrification is justified and has been a complete success, and it is my purpose in this paper to make comparisons between the two types of drives on these particular auxiliaries.

It should be clearly understood at the start that a positive selection between hydraulic and electric drive for a certain unit is not advocated here as the particular conditions affecting the installation under consideration all have to be carefully taken into account. Climatic conditions as to atmospheric temperature variations affect such selection to a very considerable extent. For instance it is very desirable to eliminate all hydraulic power possible where mills are located in very cold climates or where it is not possible to protect a piece of apparatus from severe cold weather. Where an hydraulic system is already installed and hydraulic power is available, it is often more preferable, when considering an additional piece of apparatus which is considerably simplified by driving from a piston and cylinder, to hold to the hydraulic drive. Often good judgment dictates that an electric driven hydraulic plant for taking care of auxiliaries which are considerably simplified with hydraulic

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Paper read before Philadelphia Section of the A. I. S. E. E.

rather than with electric drive, is the best installation; as in the case of large bloom or slab shears which would require a flywheel motor generator set and special driving motor if electric drive were used.

From the control standpoint the electric drive almost always has an advantage over the hydraulic drive, for the electric controller is usually a more convenient piece of apparatus for an operator to handle than an hydraulic valve, and for adaptability to location it has a decided advantage over the valve.

The distance of the piece of apparatus under consideration from the hydraulic supply mains is quite a factor in making a selection between the two types of drive, as it is very costly to transmit hydraulic power any distance due to expensive piping, loss of power due to friction, and liability to leaks. On the other hand such distance is no item whatever with electric transmission. The expense of operating an hydraulic system is very high if constant vigilance is not maintained to avoid leaks and to keep dirt and grit out of the water in the system.

The main difference between the two kinds of power under consideration is that one more readily is transferred into a reciprocating motion and the other into a rotary motion. To convert either of these forms of motion into the other form requires certain mechanical devices which are always quite an item of expense and which introduce factors affecting speed of operation and efficiency. Considering two drives, one hydraulic and the other electric, for operating a certain piece of apparatus having a straight line motion, if the hydraulic engine and the electric motor were built under the same specifications as to capacity and ultimate speed of the apparatus they drive, without the specifications having outlined a complete duty cycle, the probable result would be that the speed of acceleration of the two equipments would be somewhat different for the following reason: with the electric motor drive the torque developed in the motor has considerable work to do in overcoming the inertia of the motor armature and other rotating members in the drive, while the force acting on the piston of an hydraulic drive usually has fewer parts to accelerate and considerable less inertia to overcome. The control of each equipment is a factor in the time of acceleration, since with the electric motor, the torque is proportional to the current and the controller regulates the current to the motor; while with the hydraulic equipment the control valve admitting the water regulates the quantity of flow to the cylinder which affects the force acting on the piston. It should be pointed out in the one case the feature limiting the torque which can be developed by the motor is the mechanical and electrical limits of the machine itself, while in the other case the pressure on the hydraulic system limits the force available for doing work.

With regard to efficiency, the electric drive has an advantage over the hydraulic drive in that, to perform a certain cycle of operation only sufficient electrical energy is taken from the source of supply to do this work, making due allowance for friction losses, etc.; while the hydraulic piston usually has to complete its stroke to go through the cycle, requiring the cylinder to be filled irrespective of the amount of work to be done. Pressure engines are very efficient at full load but their efficiency decreases as the load decreases. With the electric motor the efficiency varies but slightly between wide limits of load.

Considering then each of the particular auxiliaries before mentioned which under present day practice are being installed with either method of drive:

Furnace Door Hoists.

The operating mechanism for a furnace door is usually quite simple when hydraulic power is used. A cylinder and piston is supported above or behind the furnace for each door, and the door is handled by this piston through chain or cable which passes over a sheave attached to the furnace directly over the door. When electric power is used the cylinder and piston is replaced by electric motor, connected with suitable gearing to a crank which has a throw equal to the maximum lift of the door. Sometimes a special motor driven drum is used instead of the crank as in the case of the electric door hoist. With the electric drive the door is usually counterweighted. In cases where the control for a great number of furnace doors is grouped in a pulpit, the electric drive has a decided advantage. Sometimes an electric operated valve is used with an hydraulic drive when this pulpit control is desired.

Table A gives a comparison between hydraullic and electric drive for a heating furnace door:

Table A—Furnace Door Hoists.

	Hydraulic	Electric
Initial cost	$703.00	$2,009.00
Power per year	4.40	5.15
Maintenance and repair (labor)	93.60	10.40
Cost per year (material)	62.40	20.80
Depreciation and interest	70.30	200.90
Total expense per year	230.70	237.25

Furnace Covers.

The apparatus for handling a furnace cover is in a great many respects similar to the furnace door hoist except that in this case a motion of translation is required instead of a raising and lowering motion. The soaking pit furnace cover is usually carried on wheels and made to traverse back and forth over the furnace by means of an hydraulic cylinder anchored to the furnace at one end and connected through piston and a long rod to the cover. When the electric drive is used the cylinder is replaced by a motor and suitable gearing, meshing into a long rack which is attached to the cover. Sometimes the electric motor drives a long rod, attached to the cover, back and forth through a suitable friction, and in this way one motor can be used to handle more than one furnace cover.

The points as to convenience of control hold the same in this case as with the furnace door.

Table B gives data on the two methods of drive:

Table B—Furnace Covers

	Hydraulic	Electric
Initial cost	$4,020.00	$8,150.00
Power per year	11.75	9.36
Maintenance and repair (labor)	105.00	24.00
Cost per year (material)	83.20	46.80
Depreciation and interest	402.00	815.00
Total expense per year	601.95	895.16

Elevators.

The elevator used in the steel mill very closely resembles the general freight elevator used in commercial work. In its most common form, the hydraulic elevator consists of a suspended cage carried by tackle, the running part of which is connected with a set of pulleys at each end of a frame. The rope is made fast at one end and its intermediate part is carried first round one pulley at the farther end of the frame, and then around another at the near end. The farther end pulleys are made to traverse the frame by carrying them on the end of a piston rod which is actuated from an hydraulic cylinder. The operation of this piston combined with the weight of the cage carried on the one end of the rope causes the elevator to lower or raise as the piston works out of or into the cylinder. In the case of the electric elevator the cables which support the cage are wound around drums which are turned by a motor through suitable gearing.

Table C gives data on each type of elevator for a particular installation:

Table C—Elevators.

	Hydraulic	Electric
Initial cost	$41,000.00	$22,000.00
Power per year	1,944.00	691.20
Maintenance and repair (labor)	434.00	425.00
Cost per year (material)	890.00	720.00
Depreciation and interest	4,100.00	2,200.00
Total expense per year	7,368.00	4,036.20

Blooming Mill Manipulator.

The side guard manipulator for handling and turning steel during the rolling process in the blooming mill is at the present time the manipulator most commonly used. Esstentially it consists of two long heavy steel plates carried vertically on edge directly over the mill live table rollers, one toward either side of the table. These plates are supported from independent movable beams located underneath the table, by means of arms extending up between the table rollers. The beams, of which there are usually two to each plate or guard, are carried on guide rollers and attached at the ends to hydraulic pistons, or through suitable rack and pinion to electric motors, which actuate the plate or guard back and forth in a direction parallel to the axis of the table roller. A piece of steel on the table can be caught between the two side guards and carried back and forth across the rollers to any desired position. To turn the piece, fingers are provided, which work vertically up and down just inside one of the guards. These fingers are carried with the guard on suitable supports and by means of a separate cylinder and piston; or electric motor and crank mechanism, acting through a lever shaft, and bell cranks, receive the vertical motion mentioned.

Table D gives a comparison between two such drives for a particular manipulator:

Table D—Side Guard Manipulator Drive.

	Hydraulic	Electric
Initial cost	$22,566.00	$23,850.00
Power cost per year	2,308.80	898.56
Maintenance and repair (labor)	220.80	93.60
Cost per year (material)	271.00	145.20
Depreciation and interest	2,256.60	2,385.00
Total expense per year	5,057.20	3,522.36

Lifting Tables and Middle Roll Balance.

These two mechanisms are usually considered together on a three high plate mill and will be so considered in this comparison. Essentially the hydraulic lifting table mechanism consists of a cylinder located under the table, having a piston and rod connected through a link to a suitable system of bell cranks which actuate the table vertically up and down according as the piston is forced into or out of the cylinder. With the electric driven lifting table the motor drives through reduction gearing to a crank shaft which through a connecting rod actuates the bell cranks above referred to. In each case the tables are usually counterweighed. The hydraulic middle roll balancing mechanism consists of cylinders carried on the mill housings, the pistons of which transmit a vertical motion through the rods to heavy link members connected at the lower ends to centers of beams which are attached through rods at one end to the mill housing in such a way as to give a straight line motion to the other ends which carry the middle roll. With an electric drive the motor is connected through reduction gearing to a crank shaft which imparts a vertical motion to heavy hollow weights open at the bottom, by suitable connection through rod, shaft, and bell cranks. These weights telescope over other weights pinned to one end of walking beams which are supported at their center on trunnions carried on pedestals under the mill housings. To the other ends of these beams are pinned yokes each carrying two vertical rods which support at the tops a shoe carrying the middle roll. Ordinarily the middle roll overbalances the weight on the end of the walking beams and stays in its lower position, but when the telescopic weight is lowered on the top of this weight the balance is overcome and the middle roll rises to its top position. To prevent a severe shock when this telescopic weight is lifted through the gearing, crank shaft, and levers; it is supported by a heavy spiral spring interposed between a rod carrying the weight and the actuating lever.

Table E gives data on the two methods of drive for a particular mill:

Table E—Lifting Table and Middle Roll Balance.

	Hydraulic	Electric
Initial cost	$36,370.00	$41,600.00
Power per year	14,030.64	3,895.00
Maintenance and repair (labor)	588.72	285.60
Cost per year (material)	787.20	518.40
Depreciation and interest	3,637.00	4,160.00
Total expense per year	19,043.56	8,859.00

Shears.

An hydraulic shear is probably the simplest piece of hydraulic machinery in the mill. It usually consists of a heavy frame carrying at one end in a suitable housing a knife blade, and at the other end a cylinder. The piston carries the other knife blade and works in and out of this cylinder producing a shearing action between the blades. Hydraulic shears are usually built up-cut or down-cut. The particular shear selected for this comparison is one of the latest design using a steam intensifier for securing pressure for the cutting stroke. With this arrangement there are two distinct hydraulic systems used, one a closed system directly between the cutting cylinder and the intensifier, and the other the regular mill system connected through suitable valves to cylinder for the return stroke. By using the steam intensifier greater economy is gained as the expansive power of the steam is utilized also; it is possible to get up to working pressures of 6,000 pounds per square inch.

The electric driven shear requires a considerably heavier frame casting. The lower shear blade is held stationary in this frame and upper shear blade receives its motion through either a crank, eccentric, or cam action. The driving motor is geared through countershafting to this crank, and a heavy flywheel is mounted on the countershaft. Usually the motor and flywheel are allowed to run continuously, the shear being operated by throwing in a clutch on the countershaft. More recently, on account of trouble encountered with such a clutch, the flywheel has been omitted and the motor geared directly to the shear, the motor being started and stopped in this case with each cut of the shear. Such a design of motor driven shear is the one considered in the following calculations. It is interesting to note here that the electric motor was not the pioneer driver for this type of shear arranged to start and stop at each stroke of the knife, as it was the English mill practice to use steam engine for this as early as 1896; however, as in the case of the roller table drive it is reasonable to assume that our ally has long since discovered that the electric motor is better adapted to this drive from the standpoint of economy and ease of control.

Table F gives data on the two types of drive for a particular bloom shear application:

Table F—Shears.

	Hydraulic	Electric
Initial cost	$22,640.00	$39,600.00
Power per year	5,723.47	4,310.70
Maintenance and repair (labor)	328.00	135.60
Cost per year (material)	385.76	334.00
Depreciation and interest	2,264.00	3,960.00
Total expense per year	8,701.23	8,740.30

Summary.

With each of the foregoing comparisons, in the case of the initial cost of the hydraulic drive the proportional cost of an electric driven hydraulic pumping station is included.

The fixed charges are always one of the main items of expense, and this is taken in all cases as being 10 per cent of the initial cost. Except in the case of the furnace door and cover drives the item of power is highest or second highest. The cost of a unit of electrical energy was taken as being 1 cent per kw hour.

To obtain the cost of power with hydraulic drive a test was conducted on the pumping plant shown in figure 7, which consists of three 7¼x24" horizontal, duplex, end packed, plunger pumps, each direct connected through reduction gearing to a 350 hp ac slip ring motor. An automatic governor is arranged to start and stop the motors one at a time, depending on the demands on the hydraulic system. By means of a large accumulator located outside of the pump house the pressure is maintained constant at approximately 750 pounds. The results of the test mentioned show a power consumption of eight watt hours per gallon of water pumped.

Under maintenance and repair costs are considered: With the hydraulic drive, cylinder and rod packing replacements, cup leather and valve renewals, and lubrication; with the electric drive, controller repairs and contact renewals, motor brush and pinion renewals, and lubrication.

It should also be remembered that the prices here shown do not hold good in general, as they are all war prices and cover a particular installation at a certain location. The figures are only given for the purpose of making a comparison.

Conclusions.

Reviewing each of the tables we may then draw the following conclusions: In the case of the furnace door hoists the expense of operation is about the same with hydraulic or electric drive. The initial cost of the electric drive is almost three times that of the hydraulic drive.

With the furnace cover drives the advantage as to expense of operation and initial cost lies with the hydraulic drive. It should be remembered, however that ease of control has a decided advantage in the case of the electric drive, and the hydraulic furnace covers for a large mill might require more operators than electric covers, in which event the expense of one additional operator would more than offset saving indicated with the hydraulic drive.

The electric driven elevator has an advantage over a hydraulic elevator in both operating expense and initial cost.

For driving the side guard manipulator the electric motor has an advantage over the hydraulic cylinder in operating expense and the initial cost of either drive is about the same.

The electric drive for lifting table and middle roll balance on a three high plate mill costs considerably more than hydraulic drive, but has a decided advantage over the hydraulic in operation expense.

There is comparatively no difference in the cost of operation between an electric driven and an hydraulic bloom shear, but the initial cost of the electric drive is considerably higher than that of the hydraulic drive.

There is probably very little difference between the reliability of the hydraulic drive and that of the electric drive in each of the above mentioned applications, however, some of the members of this association may have a different idea of this, and I would like to have such ideas brought out in the discussion.

Before closing this paper it should be pointed out that the hydraulic field covering large power presses and forges has not, up until the present time, ever been invaded by the electric motor, but this does not necessarily mean that the electric drive cannot be adapted to do this work. More than likely it is the prohibitive cost which has kept the electric motor out of consideration. The motor driven intensifier, before mentioned, is the entering wedge for the electric drive in this field.

The writer wishes to express his appreciation and thanks for the kind assistance of A. T. Keller in preparing this paper.

Electrical Cleaning of Blast Furnace Gas

Clean Dry Gas for Use in Hot Stoves and Boilers at Minimum Expense—Possibilities Opened for Potash Production. Data Concerning Electrical Precipitation.

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There is one thing that practically all furnace operators are desirous of obtaining, that is, high blast heats. To obtain these high heats, many blast furnaces have during the last few years, built additional hot stoves, others have put in dry dust catchers and still others have put in washers. It has been fairly well demonstrated that high blast heats materially decrease the cost of manufacturing iron by increasing the output per day and decreasing the coke consumption per ton of iron made.

The delivery of a hot blast to the tuyeres of a furnace is not a small economy but a large one. The tremendous volume of air that is discharged per minute into the focus of a furnace can carry with it a number of Btu's that will amount to thousands of dollars in a very short time. It is not the intention to discuss here the securing of a hot blast by the addition of hot stoves but to discuss the possibility of taking the gas as it exists at present in the various furnaces in the country, especially at those plants where no gas cleaning system at all is used, and treating it in such a manner as to render the gas more valuable for heating purposes. There are several systems of cleaning gases in order to render them fit for consumption in hot stoves and boilers. Some of these systems are of the dry type but most of them are of the wet type. The advantages that the dry system has over the wet system are so numerous and have been discussed so many times that it is not worth while taking this matter up here again. It has been, however, more or less impossible to use a dry type of cleaner without sacrificing the efficiency of the cleaning operation or sacrificing the economy of cleaning. Those systems that depend on the bag filter media must of necessity have the gas cooled before it is treated. Those systems which depend on the other filter media or upon any centrifugal action or upon any decrease of velocity and consequently carrying powers of the gases must of necessity sacrifice efficiency. It is for these reasons that the art of dry gas cleaning has not developed more rapidly than indications show.

The solution of the problem of cleaning any gases that contain dust and fume is dependent upon the recognition of the true condition of the gases coming from the blast furnace and the application of some device that will eliminate that portion that is not desirable in the gases.

The gases that issue from the blast furnace are fourfold:

1. True gas.
2. Vapors.
3. Fume.
4. Dust.

A true gas is one which follows the laws that apply to what are known in chemistry and physics as gases. Under this heading would come the gases which follow the law of Boyle and Charles. With true gases the application of a double pressure will reduce the volume of the gas one-half provided the temperature in both instances is the same. A true gas when the temperature is doubled will have its volume doubled provided the pressure is the same in both instances. A decrease in temperature will not precipitate out of these gases any material, whether liquid or solid. It will simply cause a decrease in the volume of the gases under the same conditions of pressure. In a true gas the volume occupied by the gas, and the pressure exerted by the gas are due to the rapidity with which the gas molecules bombard each other and the sides of the receptacle in which they are contained. Any true gas may be pictured as made up of thousands of infinitesmally small particles traveling at a tremendous rate of speed in a confined area bombarding each other and the sides of the receptacle in which they are contained causing pressures against the sides. These gases in a blast furnace may for our present purposes be considered as gases that are desirable in the ignition at a burner's point. They are the gases that contain the CO element that is of value to the blast furnace operator in producing the heat necessary for raising the temperature of his hot stove brick work to the desired point. All other gases that come over, namely vapors, fume and dust are undesirable, and their elimination is to be preferred if the expense of elimination is not greater than the loss they cause by their presence in the gas at the time of burning.

Vapor existing in blast furnace gases may under certain conditions resemble true gases in their action. For correct temperature and pressure conditions, a vapor will be a gas. If these conditions of temperature and pressure are changed, however, the vapor is likely to revert to the form in which it originally existed under normal temperature and pressure. This, however, is not true if the critical temperature has been reached.

The vapor in a blast furnace gas usually exists in the form of a superheated steam as the pressures at the top of the furnace are extremely low and the temperatures are higher than those at which steam is formed at atmospheric conditions. These vapors are usually driven off from the ore which when charged contains certain amounts of moisture. The amount of vapor that is found in blast furnace gases consequently varies according to the moisture content of the ores charged. In places where ores are very dry, the moisture consequently varies according to the moisture content of the ores charged. In places where ores are very dry, the moisture content is very low. In other places where the ores are wet, the moisture content is higher. Normally, there will be found in the gases between 20 and 40 grains of moisture per cubic foot of gas at 32 degrees F.

The fume that is found in the gases is usually made up of the volatile portion of the ore that has been driven off by the heat in the furnace. In the blast furnace, a great deal of the fume exists in the form of potassium salts and when some ores are charged, zinc will also be found in the fume. For ease in visualizing what the nature of a fume is, it may be said that a fume is the vapor of a solid and bears the same relation to a solid that a vapor does to a liquid. With a high enough temperature and the proper pressure conditions, a fume will imitate a gas in its action. Cooling however, will convert this fume back to a solid form in which it originally existed.

The removal of fume from blast furnace gases is by far the most serious problem offered to the blast furnace operator. It is mainly due to the fact that most dry dust catchers have thus far been unable to remove the fume that the dry system of cleaning has not been successful.

Dust is made up of small particles from the original ore containing metallic and silicate substances that are blown over by the force of the blast. These particles may be very small and of an impalpable nature while others may be the size of a pea. In cases of slips, the particles that are blown over can no longer be called dust.

Of these three substances which it is desirable to remove from the gases before burning, the vapors are usually not touched by any cleaning system. Wet cleaners add to the vapor content of the gases excepting when the gases are successfully cooled to a very low temperature at which point condensation of moisture reduces the vapor content of the gases. In dry systems, the vapor content of the gases remains practically the same and the loss due to radiation is so small that very little vapor is eliminated. However, the absolute elimination of vapor is not at all necessary and the cost of the elimination in most cases is too great to warrant the expenditure and the results obtained are too small to be of much economic importance.

The dust and fume, however, must both be removed if the best efficiency is to be secured in the burning of the gases. It was not until Dr. F. G. Cottrell, now chief metallurgist of the Bureau of Mines invented the Cottrell system of electrical precipitation that there was found a means of removing not only the dust but also the fume from the gas by a dry system. The principle of Dr. Cottrell's system has been fairly well described in numerous technical journals and the interest that has been shown by various industries in the Cottrell system has caused the process of electrical precipitation to be investigated by myriads of persons to whom the problem of the cleaning of the gases is interesting. It has only been lately, however, that the Cottrell system of electrical precipitation has been applied to the blast furnace gases. For nearly a year there has been a great deal of work done with small plants to determine the best means and the best designs for cleaning the blast furnace gases by electrical precipitation. This study has resulted in the building of three full sized plants for blast furnaces, probably all of which will be in operation before the end of the year. By electrical precipitation, it has been found possible to clean the gases of practically all of the dust and all of the fume.

Where zinc has been present, electrical precipitation has very successfully eliminated the zinc also.

When it is realized that potash and other alkali salts contained in the blast furnace gases in the form of fume make up a flux that is second to none in fusing qualities and fuses with the brick work with the resultant destruction of the efficiency of the hot stoves, it cannot be considered other than that the value of

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any system that will remove these alkali fumes is a great one. Those operators who have had experience with zinc in the gases can undoubtedly recollect the many times that they have attempted to wash out their mains when clogged with zinc deposits and have had pieces as large as their fists come out in the form of a stratified deposit. Electrical precipitators placed immediately after the dust catcher will remove practically all of the dust and the fume whether the fume is potash or whether it is zinc.

All ores contain potash, consequently all furnace gases will contain some amount of potash. Analysis that have been made on iron ores throughout the country indicate that practically none of the ores are free from potash. The manganese ores are exceptionally rich in potash. A recent examination of Southern iron ores has shown that some of the ordinary brown and red ores in Alabama contain nearly 1½ per cent of potash.

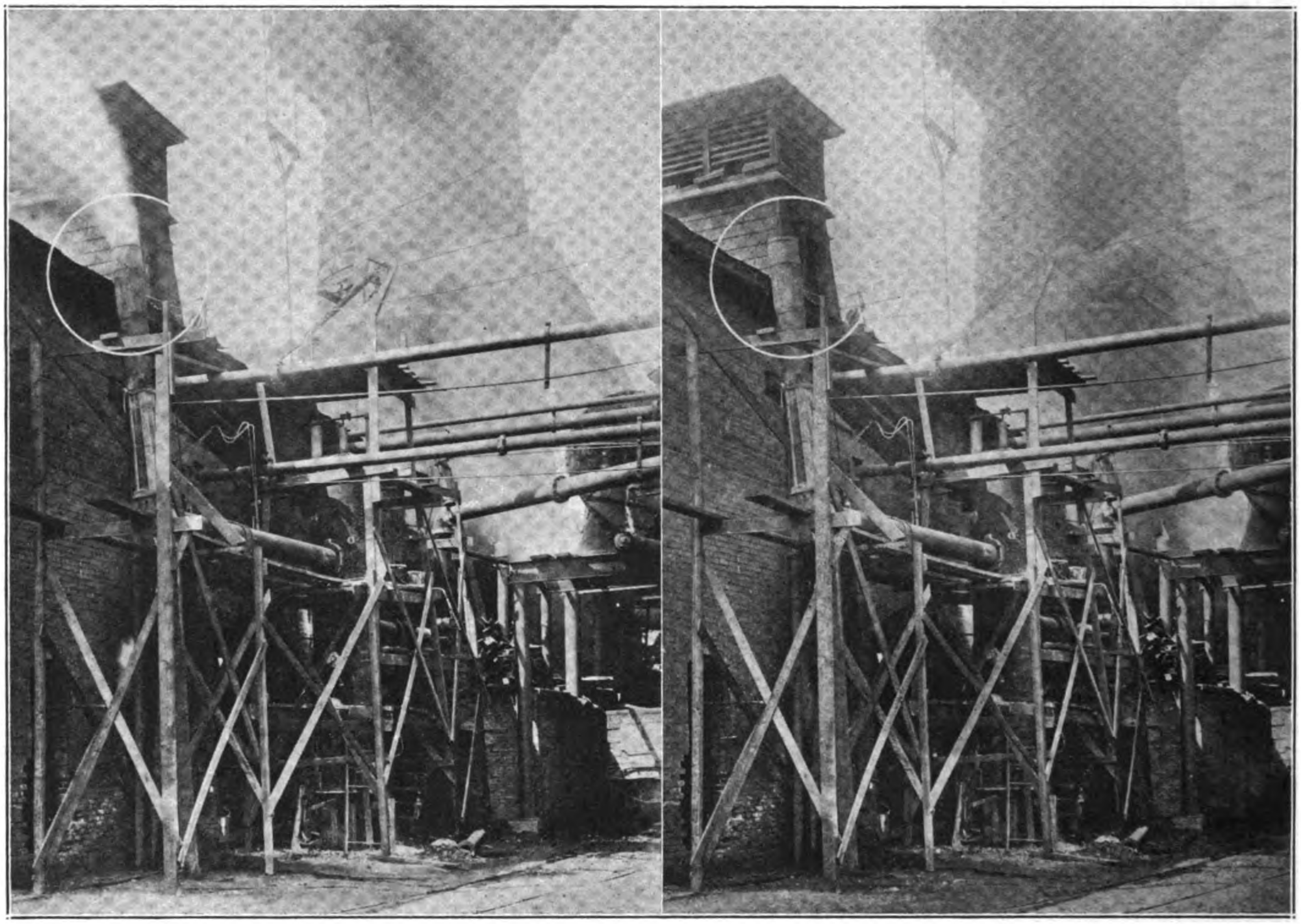

Fig. 1. Fig. 2.

Photographs taken during test of electrical precipitator. The gases were discharged into the air in order to see what effect electrical precipitation had on the gases. Fig. 1 shows the gases passing directly through the precipitator with no current on. Fig. 2, taken three minutes later (when the current was turned on) shows the remarkable clean up.

It has been found that as a rule the ores used in iron making are lower in potash than those used in the manufacture of spiegeleisen and ferromanganese. The ores used in the manufacture of spiegeleisen are next in potash content and those in ferromanganese are the highest. A great many of the manganese ores contain zinc in addition to potash and some of them contain large amounts of zinc. It therefore is especially necessary in ferromanganese making to remove the potash and the zinc before burning the gases. Iron ores have been found to contain between two-tenths to 1¾ per cent of potash. Some of the iron ores high in potash that have ben analyzed by us indicate the following:

	Iron	Mang.	Silica	Zinc	Potash	Loss on Ignition	H_2O
Ore	48.80	1.51	14.20	1.197	1.45	10.00	.84
Ore	47.00	0.00	16.02	0.593	1.54	10.00	.96

Some of the ores used in the manufacture of speigeleisen that have been analyzed by us have shown the following:

	Iron	Mang.	Silica	Phos.	Potash	Moisture
B Ore	39.80	8.21	18.09	.114	.505	11.11
C Ore	35.05	11.10	16.56	.110	.570	10.00
Ferro	25.00	20.59	19.79	.081	.945	9.30
B Ore	....	....	....	...	.490	....
C Ore	....	....	....	...	.580	....
Ferro	....	....	....	...	.978	....
A Ore	26.00	23.57	16.74	.148	.390	4.50
A Ore	....	....	....	...	.410	....

Of the ores that we have examined that are used in the manufacture of ferromanganese, there seems to be a fairly clean cut difference in the potash content between various kinds of ores. Brazilian ores run highest in potash as the following analysis shows:

	Iron	Mang.	Silica	Phos.	Potash	Moisture
Brazilian	3.60	44.90	7.00	0.15	1.95	9.00
Brazilian	3.75	39.03	11.50	.035	2.07	12.30
Brazilian	10.53	33.83	5.60	.170	1.00	9.10

It was at first thought possible that the potash content might vary as did the manganese content but the fact that there was 1 per cent of potash in the Brazilian ore running 33.83 per cent manganese and 2.07 per cent of potash in an ore running 39.03 while only 1.95 per cent was contained in the ore running 44.90 per cent of manganese, seemed to indicate that there was no direct relation between the potash and the manganese content.

Next to the Brazilian, the Indian ores have the highest potash content as the following analysis indicates:

	Iron	Mang.	Silica	Phos.	Potash	Moisture
Indian	6.00	50.85	5.60	0.08	1.84	0.10

The Costa Rican ores run high in potash as indicated below:

	Iron	Mang.	Silica	Phos.	Potash	Moisture
Costa Rica	1.90	50.46	9.00	.042	.95	.95

The Cuban ores run next in potash content as the following table will show:

	Iron	Mang.	Silica	Phos.	Potash	Moisture
Cuban	2.85	39.86	10.50	.026	.91	6.50
Cuban	2.65	40.31	13.95	.066	.83	6.00
Cuban	4.85	44.85	11.60	.070	.85	10.00

In addition to the ores, the rest of the burden carries potash. Limestones vary in their potash content and average between three-tenths to four-tenths per cent K_2O as per the following analysis:

	Iron	Lime	Silica	Mang.	Potash
Limestone	.25	29.70	2.50	20.57	.36

The coke analysis also indicated potash content as per the following:

	Iron	Vol.	F. C.	S.	Ash	K_2O	Moisture
Coke (National)	.87	1.50	85.40	1.00	13.10	.21	1.60
Coke (Keystone)	.70	1.35	86.55	1.03	12.10	.078	2.95

Proximate analyses here run pretty close together yet the K_2O content of the two cokes are very different. This agrees with other experiments made. The potash content of coke variation is so great that no definite rule can be applied to it.

Notwithstanding the fact that the electrical precipitator has been used on blast furnaces making pig iron, spiegeleisen and ferromanganese, cleaning results in all cases have indicated that the kind of iron made or the kind of operation at the plant had very little to do with the cleaning effect of the precipitator. Electrical precipitation has successfully cleaned gases containing as low as one-half grain of dust per cubic foot and has reduced this dust content to less than five-hundredths of a grain per cubic foot. The precipitator has successfully treated gases containing two and one-half grains per cubic foot and has reduced the dust content to one-tenth of a grain per cubic foot. Both of these results were obtained when working on gases from ordinary blast furnaces. At the very extreme, the precipitator had handled gas running as high as 12.685 grains per cubic foot and has reduced the dust content in the gases to .205 grains per cubic foot.

Some total dust clean-ups for various conditions by the use of electrical precipitation on blast furnace gases have been as follows:

Grains Dust Per Cu. Ft. of Gas		
Untreated	Treated	Per Cent Clean Up
.445	.046	89.7
.658	.100	84.8
.707	.125	82.3
1.150	.118	89.8
.500	.033	93.4

This means that practically all the dust that is usually found in the hot stoves and boilers and in the balance of the gas system can be eliminated at the very outset immediately after the dry dust catcher. It is found that about 50 per cent of the total dust that comes over from the furnace is collected in the dry dust catcher. This dust, however, is of a coarse nature and contains less than 1½ per cent potash even when the ores themselves contain over 1½ per cent potash. The balance of the dust consisting of very small particles and all the fume passes beyond the dry dust catcher. It is at this point that electrical precipitators can recover what the dry dust catcher was unable to get. The very fine particles and the fume particles are those that contain potash. Some cleanups that were made on blast furnace gases for potash content in the dust are indicated below:

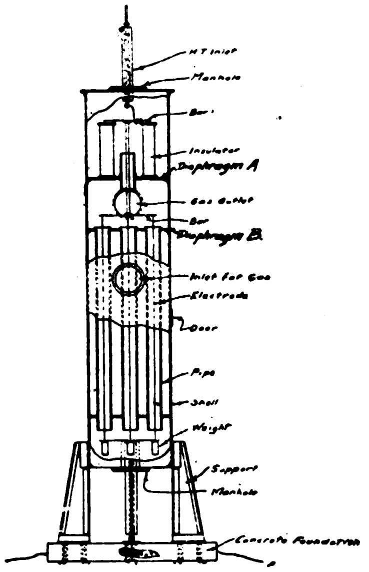

Fig. 3—Small experimental electrical precipitator.

Grains K_2O Per Cu. Ft.		Per Cent K_2O
Untreated	Treated	Dust
.0895	.01275	85.7
.1615	.02661	83.5
.1740	.03330	80.9
.1905	.03010	84.3
.0487	.00593	87.8
	.00846	
	.01280	

It is difficult to visualize in figures just what cleanup by electrical precipitation means. Photographs that were taken during the actual running of a precipitator where the gases were discharged into the air in order to see what effect electrical precipitation had on the gases are shown in the illustration. In Fig. 1, the gas was passing directly through the precipitator with no electric current on. In Figure 2, which is a photograph taken about three minutes after that of Figure 1, nothing has been done except to throw in a single switch, thus putting the electric current on the electrodes in the precipitator. The visual cleanup as shown is just short of remarkable.

An electrical precipitation plant is a very simple one and contains very few moving parts. The supervision of one man is all that is necessary and there is practically no labor required excepting that for the removal of dust. The same men who now remove the dust from the balance of the plant can remove it from the precipitators with more ease and with much less labor.

Apart from the fact that the potash and dust can be removed by electrical precipitation, there is another item that is of extreme importance and especially at this time when there is such a fine opportunity for developing a new industry in the United States. It has been fairly well recognized by those familiar with the potash situation in the United States that the time is coming for this country to build up its own potash industry. The monopoly of Germany on the potash industry of the world has been broken and it is only by the development of an American potash industry that this monopoly can be kept broken. The blast furnace promises to be one of the greatest producers of potash in the country and at perhaps the smallest cost of any other source. The potash recovered in the blast furnace can be sold for a present price of $3 per unit f.o.b. point of delivery, Eastern market. An ordinary blast furnace with about a 200-ton capacity running on pig iron ought to be able to collect by electrical precipitation one ton of potash per day. This would mean a receipt of $300 per day for the potash collected in the process of cleaning the gases. Out of this, more than half can be charged up as a profit while the entire cost of cleaning the gases can be charged up to the potash. Even if there should be no sale at all of potash, the net gain of clean gases is far in excess of the cost of operating a plant but since there is a possibility of disposing potash at a good price, there is a double inducement to the blast furnace operator to put in a Cottrell electrical precipitator as a cleaning device. Cement plants which have been operating Cottrell electrical precipitators for sometime and some of which are now operating electrical precipitators have been selling their flue dust with as low as 8 per cent potash for a very high price.

There is a further possibility of so treating the flue dust that practically pure potassium salts can be secured at a very small additional cost and consequently the potash can be sold in the chemical market where the price is much higher than that before indicated. That this is not an impossibility and that the chance of a potash industry coming from the blast furnace industry is not a small one, may be indicated by the results obtained in actual precipitation work on blast furnace gases. Several runs were made to determine, when the subject was first taken up, a number of points. These were:

1. Whether the Cottrell electrical precipitator will successfully remove the dust from the gases coming from the furnace making basic iron, spiegeleisen or ferromanganese.

2. Whether this precipitation will render the gas clean enough for use in the hot stoves and boilers connected with the furnace plant.

3. Whether the dust so obtained would have any commercial value.

4. What factors were influential in the precipitation of the flue dust.

5. What were the correct quantities of the factors influencing such precipitation.

The apparatus that was used in conducting these experiments consisted of a small electrical precipitator with the proper electrical apparatus to treat approximately 1,000 cubic feet of gas per minute in a way comparable with the method used on a large scale.

A small electrical precipitator was built of the enclosed type and so connected that the treated gas could be fed into a boiler for ignition. The precipitator consisted of a shell made of about ¼-inch thick sheet steel which had previously been used as a condenser but was not in use at the time. The shell was about 15′ 0″ long and was 40 inches in diameter. The top and bottom heads were bolted to the shell by means of angle rings fitted and riveted to the shell. In each head was a manhole 18 inches in diameter covered by a blank flange bolted into place. The top hole was used for the support of a wall bushing. The bottom hole was used as a discharging door for the removal of the precipitated dust.

The shell was divided into three compartments by two steel circular diaphragms, one compartment 9′ 6″ long, the adjoining one 2 0″ long and the last or top compartment 3′ 6″ long.

The first steel diaphragm had six holes about 6½ inches in diameter, spaced one foot apart in two rows symmetric with a diameter so as to allow the insertion of six steel 6″ pipes. These pipes were hung from threaded flanges which were bolted to the steel diaphragm from below.

The diaphragm was supported by an angle ring which was riveted to the shell and bolted to the diaphragm so as to make the points of contact gas tight. Asbestos was packed around the edge of the diaphragm for this purpose. This compartment was an inlet opening made up of a casting for flanged pipe connection one foot in diameter and located two feet below the diaphragm. A hand hole about one foot below the inlet allowed for the insertion of some tapping devices to remove the dust. The space between the bottoms of the six-inch pipes and the lower head of the precipitator was used for the collection of the precipitated dust. The second or middle compartment was located between diaphragm A and diaphragm B. The outlet was about centrally located in this compartment and was one foot in diameter. A six-inch hole was also located on the shell at this level. In addition there was an 18-inch manhole bolted to the shell leading into this compartment.

The upper or top compartment contained the insulators. These were set on diaphragm A by means of two castings (see Figure 3). On these insulators rested a steel strap from which there hung centrally a 1½ inch pipe. To this pipe just above the second diaphragm was suspended an electrode hanger. This hanger was made up of steel straps so fabricated that a chain could be suspended from them into the center of each of the 6-inch pipes.

A wall bushing came through the top of the precipitator to prevent electrical leakage of the high tension current at this point. The whole precipitator was set on four legs which were bolted to a concrete foundation. An inlet pipe 12 inches in diameter connected the precipitator with the main gas line at the outlet of the dry dust catcher. An outlet pipe 12 inches and then 10 inches in diameter connected the precipitator with a boiler. A valve was located at the inlet side. A tee with a blank flange was located on the outlet side. An arrangement for blanking of the outlet end was made by sheet metal gates.

In order to insure good results the pipes were picked out from a lot so that there were no burrs on the inside as projections tend to cause premature discharge of electricity. The precipitator was gas tight. The electrodes consisted of chain weighted down with window sash weights so placed that they passed through the centers of the pipes.

The dust collected during precipitation tests when pig iron gases were treated showed analyses as follows:

Potash	9.64
	20.79
	10.27
	16.21
	5.46
	7.82
	4.56
	2.74
	16.71

The analysis when running on speigeleisen was as follows:

Potash	12.30
	10.84
	9.29

A complete analysis of the flue dust precipitated when working on ferromanganese gases is shown above.

CaO	SiO_2	MgO	Fe	MnO	Alumina	Moisture	Loss on Ignition	K_2O	Na_2O
7.42	11.10	3.20	3.00	11.20	6.00	3.00	21.30	26.46	
8.45	10.20	3.52	2.50	10.15	5.90	2.00	22.00	26.72	
9.31	9.40	3.84	2.30	8.15	5.86	1.50	17.50	28.93	2.10
9.00	10.30	3.00	2.40	9.15	4.80	2.30	19.00	25.57	
8.52	10.29	3.47	2.30	10.22	5.82	2.14	22.20	26.61	
8.25	10.19	3.45	2.10	10.12	5.87	2.08	22.31	25.53	

K_2O	Loss on Ignition	Cl	Sulphate	Sulphide	Carbonate	Cyanide	Ferro-Cyanide	Hydroxide
30.31	17.50	1.48	3.90	.70	16.50	3.10	1.00	.33

Here the potash content ran from 25.53 to 28.93. In talking of potash content throughout this report when discussing flue dust, it is understood that water soluble potash is mentioned. A study was made by us of the total potash as against water soluble potash. In flue dust that contained 28.93 per cent of water soluble potash, we found 30.31 total potash. This gives a difference of 1.38 per cent which shows that approximately 4½ per cent of the total potash coming into the gases is in an insoluble form.

There has been a great deal of discussion lately as to the amount of insoluble potash coming off from cement kilns and this total has been rather high. Due to the fact that our results show such a small amount of insoluble potash coming off blast furnaces, we have come to the conclusion that the tenets that hold for cement kiln practice for potash recovery are not applicable in their entirety to blast furnace operation. When furnace flue dust runs as high as it does in the above mentioned test in potash, it becomes advisable to remove the potash by lixiviation.

It can be readily seen from these percentages that the potash possibility for the blast furnace operator is a real one. Some blast furnaces have been collecting dust gathered in their flues and boilers and have actually disposed of this dust for thousands of dollars for purely the value of its potash content alone. We have ourselves, just sold several carloads of potash bearing flue dust running between 9½ and 12 per cent water soluble potash to the fertilizer industry. There is a plant now collecting cement flue dust running between 5 and 6 per cent of W. S. K_2O, that is turning out a product of potassium chloride over 98 per cent pure.

Dr. Cottrell has therefore opened up to the blast furnace industry a two-fold possibility:

1. That of securing a clean dry gas for use in the hot stoves and boilers at a minimum of expense.

2. That of starting a vital national industry, namely that of potash production.

Where potash is an insignificant factor in the whole game, the Cottrell electrical precipitator can vindicate itself as a power in the cleaning of blast furnace gases.

Clairton By-Product Coke Plant Equipment

Chart Showing Operating Organization of Coke Works. Complete List of Equipment, Capacity, Etc., Required in Entire Installation of By-Product Coke Plant.

By **FRANK F. MARQUARD,**

Superintendent Clairton By-Product Coke Works, Clairton, Pa.

PART II.

A comprehensive description of the Clairton by-product coke plant appeared on page 256 of the June issue of THE BLAST FURNACE AND STEEL PLANT, as presented by the author before the New York meeting of the American Iron and Steel Institute. The second and final installment of this paper presented herewith shows a table of th eoperating organization and gives a detailed list of the equipment included in this tremendous installation.

The plant equipment consists of two complete coal handling units, each unit supplying two 4,000 ton bunkers, and each unit has the following equipment:

One coal hoist; two 5-ton grab buckets; two shaker screens; two duplex roll coal crushers; one conveyor

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Final installment of paper read by author before May meeting of the American Iron and Steel Institute.

Operating Organization of Clairton By-Product Coke Works.

Department	Number of Employes 12 Hrs.	10 Hrs.	8 Hrs.	Total	Department Duties.
Coal handling	43	3	..	46	In charge of unloading coal from barges and cars; hoisting, crushing and elevating coal to bunkers.
Ovens	332	2	3	337	Charging ovens; pushing coke; receiving coke; quenching coke; luting and door extracting; cleaning dampers; etc.
Heating	51 ..	*36 1	.. ..	88	Heating of ovens; setting of nozzles; reversing mechanism; removing of carbon; flushing; regulating of gas collecting mains and suction mains.
Coke Handling	53	1	..	54	Coke from wharves; screening and loading of furnace coke, domestic coke and coke dust and movement of coke cars to scales.
By-product	104	12	..	116	Primary coolers; exhausters; tar extractor; reheaters; recovery of sulphate of ammonia; operation of ammonia stills; total gas meters and gas booster station.
Benzol	18	4	..	22	Final coolers; oil scrubbers; oil coolers; circulating cooling tower; light oil stills and refinement of all benzol products.
Mechanical	180	346	..	526	All steam boilers; water pumping station; machine shop; all mechanical labor in maintenance and repairs; locomotive cranes, and pumps and engines.
Electrical	51	56	..	107	Power house; sub-station; transformer stations; all electrical repair shop work, and all electrical repairs and maintenance.
General labor	40	210	..	250	In charge of all common labor, except such labor as have permanently fixed positions in various departments; furnish men on requisition to various departments; unloading of miscellaneous material; maintenance of tracks, sewers, water lines, etc.
Shipping	2	25	..	27	Loading and shipping coke, tar, ammonium sulphate and all benzol products.
Chemical	10	6	10	26	Sampling, preparation of samples, analyzing, all laboratory and chemical research work.
Engineering	..	..	30	30	Mechanical, civil and efficiency engineering.
Stores	1	13	7	21	Handling of stock material, spares, etc.
Clerical	..	4	18	22	Accounting, costs, records, etc.

Total employes per 24 hour day........................1,672

*Eleven hour turns.

210′ 0″ long, belt 42″ wide; one conveyor 345′ 0″ long, belt 42″ wide; one belt is equipped with automatic scale, capacity 500 net tons per hour; one conveyor, from bunker to bunker, 242′ 0″ long, 42″ belt; each bunker is equipped with shuttle conveyor, 34′ 0″ long, belt 42″ wide.

Ovens and Oven Equipment.

Twelve batteries, 64 ovens each, 768 ovens total: size of oven, 17″ wide on pusher side, 19½″ wide on coke side, 9′ 0″ from oven floor to top of coal, 9′ 10″ from oven floor to top of oven; oven 37′ 0″ long, 500 cubic foot capacity, 13.4 net tons coal. Twelve stacks 8′ 6″ diameter, 200′ 0″ high, reinforced concrete, brick lined. Twelve complete clock controlled automatic gas, air and stack damper reversing mechanism. Six coal charging larries, four bin type, each equipped with swab crane. Eight pusher machines, equipped with pusher ram, reciprocating leveler bar, and door remover. Four spillage pits. Eight coke guides. Twelve clay carriers on pusher side, and 14 clay carriers on coke side. Eight motor operated door extracting machines. Eight quenching cars and eight electric locomotives. Four quenching stations, one for three batteries; tank capacity for each quenching station 14,000 gallons; one pump house for each two quenching stations; two 2,500,000 gallon motor driven centrifugal pumps at each pump house. Four coke wharves each 164′ 0″ long, capacity of four oven charges each, rotary feeders to conveyor belt. One four-unit screening station: one unit for each coke wharf; conveyor from each wharf 42″ belt, 450′ 0″ long; four grizzly screens for furnace coke, six sections each, first section cross bars 1″ spacing, five sections longitudinal bars spacing ⅞″ on top 1⅛″ at bottom; two breeze conveyors, 100′ 0″ long, 18″ belt; two rotary screens for domestic coke and dust, 5/16″ wire screen drum, 5′ 0″ diameer, 16′ 0″ long, ⅞″ square openings, 12 rpm. Four 35-ton electric locomotives, combination third rail and storage battery type, remotely controlled, for handling furnace coke under screens to yard scales. One 200-ton capacity yard scale. Ten primary coolers, indirect tubular type, 2219 3-inch tubes 20′ 0″ long.

By-Product Building and Salt Room Equipment.

Size of by-product building proper, 92′ 0″ wide, 303′ 0″ long; salt room 92′ 0″ wide, 456′ 0″ long. Total building 92′ 0″ wide by 759′ 0″ long.

Five positive exhausters, capacity 40,000,000 cubic feet of gas per 24 hours each, direct connected to 17x36″ heavy duty, twin Hamilton Corliss engines, 85 to 125 rpm. Six tar extractors, seven bells each, differential gas pressure Tagliabue control; five reheaters; 10 saturators; 30 centrifugal dryers, belt driven by vertical steam engines, 20 hp; 10 acid separators; two motor liquor tanks, lead lined; three air compressors, steam driven, capacity 600 cubic feet of air per minute each; one 5-ton hand operated crane. Salt room storage capacity 22,000 tons, five months production; one 5-ton electric traveling crane; one salt conveyor from dryers, 360′ 0″ long, 24″ belt; one rotary salt dryer (air dryer); one gas furnace for rotary dryer; two hanging scales and bagging hoppers; one bag sewing machine; one box car loader.

Still, Lime and Pump Room.

Two 40,000 gallon capacity hot drain tanks; four centrifugal tar flushing pumps, motor driven, capacity 3,000,000 gallons per 24 hours each; two triplex vertical pumps (spares), 1,000,000 gallons capacity each, direct connected to steam engine; four hot drain centrifugal pumps, motor driven, capacity 300,000 gallons per 24 hours each; four ammonia feed centrifugal pumps, motor driven, capacity 200,000 gallons per 24 hours each; six free ammonia stills, capacity 3,000 gallons per hour each; six fixed stills; six vaporizers; six dephlegmators; six condensers.

One lime storage room 100 net tons capacity; one lime breaker; one lime conveyor; one lime slacking drum; one centrifugal lime feed pump, motor driven.

Storage Tanks.

Four 500,000 gallon tar tanks; two 300,000 gallon ammonia tanks; two 372,000 gallon tar and liquor separating tanks; two 90,000 gallon concrete basins for concentrated ammonia; four 40,000 gallon tanks for 60° Be acid; one 6,000 gallon for 40° Be acid.

Tar Loading Station.

One 100,000 gallon loading tank; one tar loading pump house; one centrifugal tar loading pump, motor driven, 360,000 gallon capacity per 24 hours; one triplex pump, motor driven, 360,000 gallons per 24 hours; 45 tar tank cars, 10,000 gallon capacity each.

Equipment for Benzol Recovery Plant.

Four final coolers, 12′ 0″ diameter, 100′ 0″ high; four naphthalene sumps; two vertical centrifugal naphthalene pumps, motor driven; 12 oil scrubbers, 16′ 0″ diameter, 100′ 0″ high.

One wash oil circulating pump house; 10 centrifugal oil pumps, motor driven, capacity 1,000,000 gallons each per 24 hours; two wash oil circulating tanks, 50,000 gallon capacity each.

Six Thomas meters, capacity 1,500,000 cubic feet of gas per hour each; one 100,000 cubic foot gas holder; two gas bleeders, 36″ diameter, 100′ 0″ high.

One surplus gas booster station; three Ingersoll-Rand turbo blowers, driven by high pressure condensing steam turbines, capacity 70,000,000 cubic feet of gas per 24 hours each, at 7 pounds discharge pressure, 2,800 rpm; one Ingersoll-Rand condenser and vacuum pump.

One cooling tower, combination forced and natural draft; three fans 12′ 0″ diameter, motor driven, capacity of tower 10,000,000 gallons of water per 24 hours, for cooling water used on direct final gas coolers.

One water recirculating pump house; two centrifugal pumps, motor driven, 10,000,000 gallons capacity per 24 hours each, for final cooler water; two centrifugal pumps, motor driven, 10,000,000 gallons capacity per 24 hours each, for circulating water over cooling tower; two centrifugal pumps motor driven, 1,000,000 gallons per 24 hours each, for well water over final coolers; 10 deep well pumps, 50,000 gallons capacity each, per 24 hours, for final gas coolers.

The light oil recovery plant consists of 10 light oil still, each equipped with rectifying column; vapor to oil heat exchanger; decanter; oil to oil heat exchanger; superheater; light oil cooler; light oil separator and decanter tanks. Two hot oil drain tanks, 30,000 gallon capacity each for debenzolized wash oil.

One debenzolized oil pump house; three cycloydal pumps, 40,000 gallon capacity per hour each, driven by steam engines; one triplex pump, electric driven, capacity 200,000 gallons per 24 hours for handling contaminated water to quenching stations; one duplex pump, steam driven, 120,000 gallons per 24 hours, for unloading wash oil and pumping oil back into system; four 8-inch oil lines, each 5,000 feet long, two for benzolized and two for debenzolized oil; one set wash oil coolers, 80 banks, open type; two wash oil circulating tanks, capacity 50,000 gallons each.

Benzol Refining Plant.

Two crude stills, each holding a 20,000 gallon charge, with columns and dephlegmators; benzol coolers; separators and receiving tanks. Seven pure benzol stills each holding 20,000 gallon charge, with rectifying columns and dephlegmators; coolers, receiving tanks. One residual drain tank 7,000 gallon capacity; one wash oil drain tank, 7,000 gallon capacity; three duplex steam driven charging pumps, capacity 20,000 gallons per hour each; one steam driven air compressor, 50 cubic feet of air per minute for Tagliabue control system; two vacuum pumps, steam driven; one ventilating fan; two pneumatic sample transmission stations; one hand operated crane, 15 ton capacity.

Agitator Building.

Four agitators 10,000 gallon capacity each, steam driven; two air compressors, steam driven, capacity 200 cubic feet per minute each; for acid and soda solution charges; four meter tanks capacity 500 gallons each, for acid; two meter tanks, 500 gallon capacity each, for soda solution; three duplex charging pumps, steam driven, 20,000 gallon capacity each per hour, to charge agitators; one traveling beam with chain blocks, 5-ton capacity; one acid feed tank, 6,000 gallons capacity; one soda feed tank, 6,000 gallons capacity; one ventilating fan; one soda mixing tank, 600 gallons capacity; one soda discharge tank, 600 gallons capacity; two acid storage tanks, 15,000 gallon capacity.

Acid Boilers.

Eight acid boilers, tilting type, to boil acid sludge from agitators; eight overhead suspended, electric motor driven, chain hoists, capacity 10 tons, one for each boiler; one acid filter, lead lined, with filter brick; two acid neutralizing pots; two acid vapor condensers; one benzol drain tank, 500 gallons capacity; two acid drain tanks, lead lined, 6,000 gallons capacity each, for regenerated acid; one acid transfer car, 6,000 gallons capacity, lead lined.

Daily Product Storage Tanks.

Two 30,000 gallon pure benzol; one 30,000 gallon (No. 1) light solvent; one 30,000 gallon pure intermediate benzol; one 30,000 gallon pure intermediate toluol; one 30,000 gallon refined first runnings; one 15,000 gallon pure xylol; one 15,000 gallon pure toluol; one 30,000 gallon pure toluol; one 30,000 gallon crude first runnings; two 30,000 gallon crude (No. 1) light solvent; one 30,000 gallon crude (No. 2) heavy solvent; two 30,000 gallon crude toluol; two 30,000 gallon crude benzol; one 30,000 gallon washed benzol; one 30,000 gallon washed toluol; one 30,000 gallon washed solvent; two 30,000 gallon crude light oil.

Storage Tanks.

One 100,000 gallon crude No. 1 light solvent; one 100,000 gallon pure toluol; one 100,000 gallon pure benzol; two 250,000 gallon pure benzol, equipped with steam coils; one 250,000 gallon new wash oil; two 250,000 gallon crude light oil; one 50,000 gallon old wash oil, with steam coils.

Crude Naphthalene Plant.

Twelve crystallizing pans, 2,500 gallons each; two centrifugal dryers, steam driven, 400 pounds capacity each. One crude naphthalene storage room.

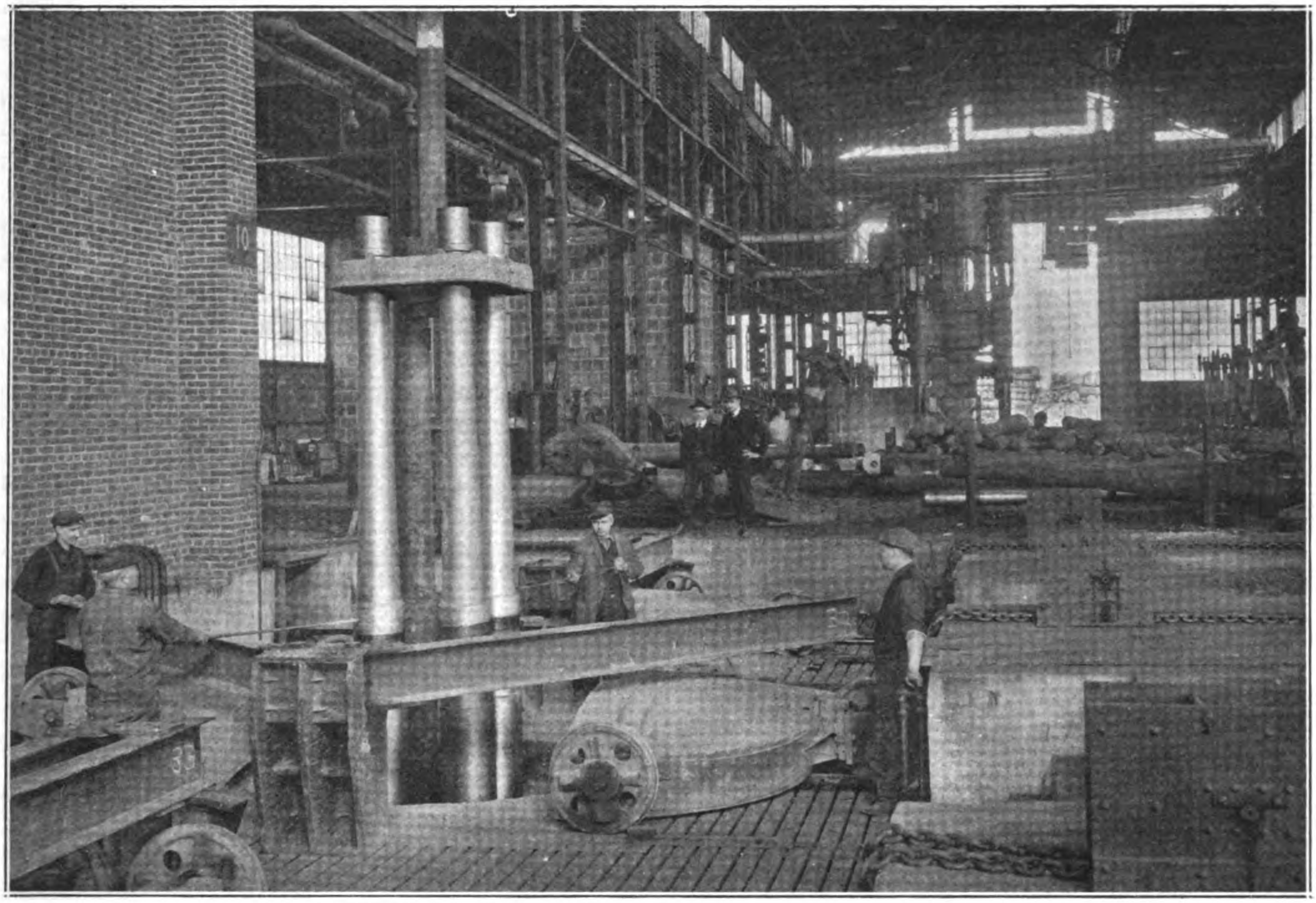
Loading Dock.

One loading building, 25′ 0″ wide, 60′ 0″ long; two loading platforms 30′ 0″ wide and 80′ 0″ long, each; four loading tanks, 2,000 gallons capacity each; two duplex loading pumps, steam driven, capacity 10,000 gallons per hour each; two platform scales for weighing drums; 5,000 benzol drums, capacity 110 gallons each; 35 benzol tank cars, 10,000 gallons each, equipped with steam coils.

Benzol Boiler House.

Six 600 hp Sterling boilers equipped with Cox chain grate stokers, soot blowers and superheaters; two blowers, turbine driven; one feed water heater, cylindrical, for exhaust steam, 20,000 hp capacity; two steam driven duplex horizontal feed pumps, capacity 600 gallons per minute each; three reinforced concrete

(Continued on Page 358)



Heat treating gun forgings in the electrical furnace. View shows interior of foundry of Tioga Steel & Iron Co., Philadelphia, Pa.

Electric Resistance Heat Treating Furnace

High Temperature Furnaces Creating 1,800° F. Used for Tempering, Hardening and for Treating Gun Forgings—Low Temperature Furnace Used for Shrinking Jackets Over Gun Barrels.

By A. M. CLARK,
Industrial Department, General Electric Company.

Demands made by the United States government during the war period for the speeding up of ordinance manufacture caused remarkable improvements in electrical furnaces, which it is predicted will have a far reaching influence on the commercial use of industrial heating in the future. Both the Army and Navy departments, faced with the necessity of manufacturing guns in great quantity and at short notice, turned to the electrical engineer to help them solve their problems.

The result was the development by the General Electric Company of a new type of electrical resistance furnace used with success in heat treating, gun forgings, and in shrinking the jackets on gun barrels of large caliber.

Two forms of furnace were developed—a high temperature resistance furnace creating a temperature of 1,800 degrees F., used in tempering, hardening, and gun forgings; and a low temperature furnace up to 950 degrees F., used primarily for shrinking jackets over gun barrels and applicable to other practices, including shrinking collars on crank shafts, rims on wheels, etc.

This type of shrinking furnace is constructed in sections and has been built up to a depth of 88 feet. The best example is installed in the Washington Navy Yard where guns of large caliber were built during the war. The furnace is of the vertical cylindrical type sunk into the ground to the required depth, a section of which is shown in Fig. 1.

Its internal construction is shown in Fig. 2. Furnaces consisting of more than one section are usually equipped with a hand control which permits bringing the charge up to temperature at a uniform rate throughout the length of the furnace, the maximum temperature used being approximately 950 degrees F.

When a one-section furnace is used, it is ordinarily provided with automatic control. Furnaces of more than one section are usually hand controlled, but automatic control can be provided.

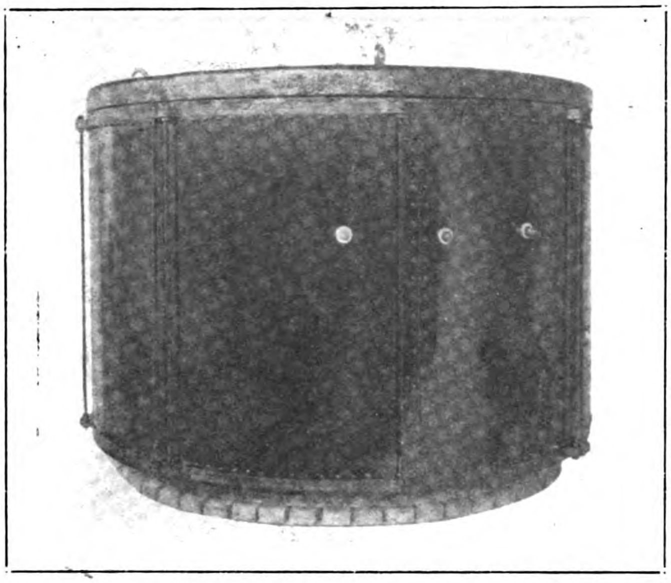


Fig. 1—Shrinking furnace with cover.

A complete one section furnace consists of a cylindrical section, cover, base and work base. The cylindrical section consists of top and bottom castings with supports, inner and outer casings enclosing the insulating material, and heating units and guards. The cast rings which form the ends of the section are recessed in such a manner that the sections can be stacked one above the other, which permits constructing a furnace of any desired height from standard sections. Provision is made for the unequal expansion of the inner and outer casings due to difference in temperatures. There is a minimum of through metal from the inner casing to the outer casting, hence the heat losses are reduced to a minimum.

The heating unit consists of a calorite ribbon mounted on a cast iron supporting plate, and insulated therefrom by suitable refractory material. A number of units are connected in series depending upon the voltage of the power supply. All connections are made with flat steel bus bars, as experience has demonstrated that the best connections can be made between flat surfaces and steel will not oxidize at the temperatures employed in these furnaces.

The construction of the vertical cylindrical high temperature heat-treating furnaces involves the use of a heavy calorite ribbon supported on the inner walls of the furnace.

The furnace is divided into a number of separate heating zones with an automatic temperature control for each. As indicated in Fig. 3, the walls consist of an inner lining of refractory brick and insulators backed up by a double course of heat insulating brick and protected by a sheet metal casing. The ribbon supports and insulators are both of moulded special compound laid in the lining of refractory brick with a spacing block of the same material placed between the insulators of adjacent windings, or zones. The insulators, spacers, and spacing blocks are fitted at the back into a steel channel H which is in the form of a ring made up of a number of sectors tied together by bolted clamps, not shown in this figure. The spacing block A acts as a protecting buffer for the ribbon support insulators and any blow is transmitted to and distributed by the channel H. An opening is provided in the spacing block A for the charge pyrometer tube, with a similar opening for the ribbon pyrometer in the support insulator at D. The ribbon is welded to the terminal stud E and adjacent lengths of ribbon are joined by welding to the splice piece J. It will be noted that the ribbon insulators are protected from mechanical injury by the spacing blocks and the shape of the former is such that any scale or dirt cannot accumulate and cause short circuiting of the ribbon winding but will fall to the bottom of the furnace. The ribbon insulators being imbedded and forming a part of the furnace wall hold the ribbon firmly in place and eliminate the need of any form of metallic support with the inherent weakness of the latter at high temperatures. Furthermore, the omission of all metal, except through ribbon windings, insures quick heating of the furnace and reduces to a minimum the waste of energy due to heat storage.

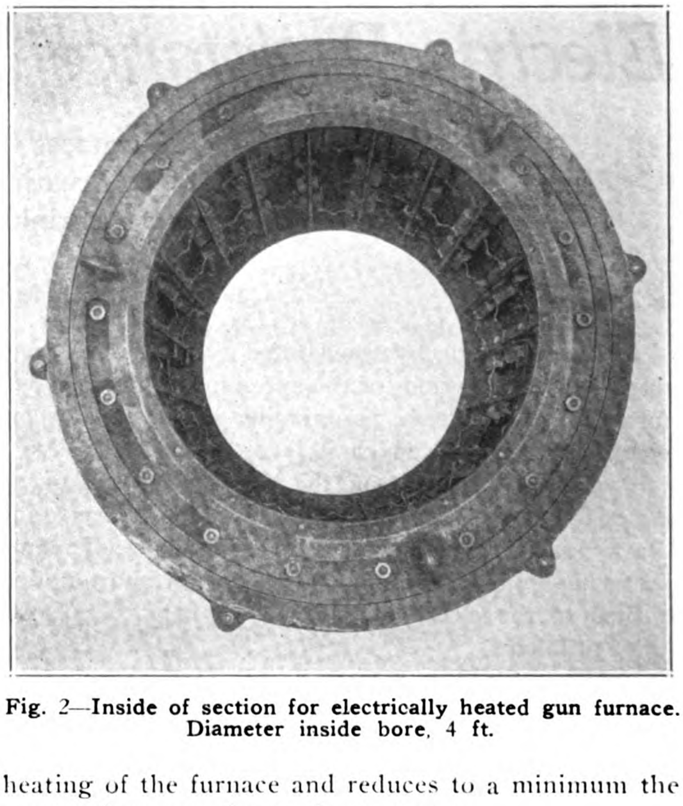


Fig. 2—Inside of section for electrically heated gun furnace. Diameter inside bore, 4 ft.

Each section is provided with a control panel, and is controlled independently of the other sections. This is accomplished by very accurate and sensitive automatic controlling instruments, one for each section, operating in conjunction with suitable relays and a contactor, so that when the temperature reaches the value for which the instrument is set, the relays and contactor are operated to disconnect the section from the power line. When the temperature has fallen only a few degrees the relays and contactors are operated in the reverse order, again connecting the section to the line.

Fig. 4 shows the control instrument, and Fig. 5 shows a control board for a group of furnaces, with the instruments on the sub-base.

The instrument may be set to hold any desired temperature, and is provided with a paper roll and recording mechanism, so that indicating, recording, and controlling features, are all combined in a single instrument, and charts are available for record and reference.

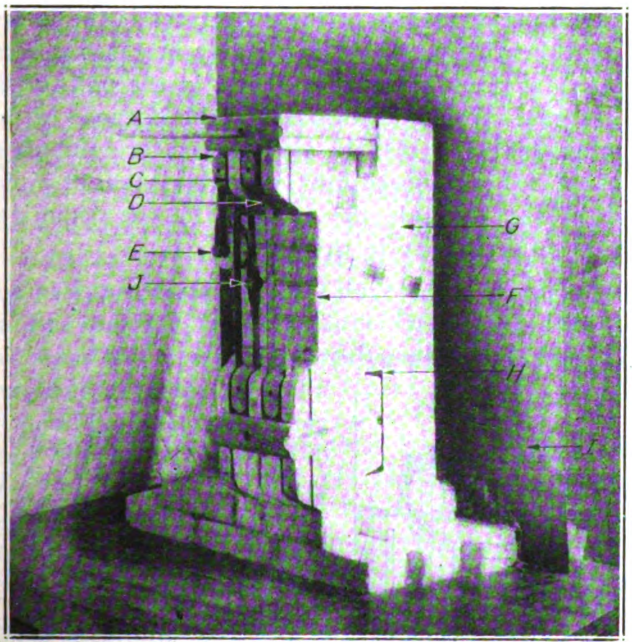


Fig. 3—Sectional view of heat treating furnace showing construction of walls and refractories for holding heating ribbons.

The temperatures are measured by means of thermocouples, which experience and research have developed into exceedingly accurate and reliable devices. There are two of these thermocouples used in each furnace section, one of which is placed near the resistor, and the other against the charge.

Probably the largest installation of this apparatus is in the plant of Tioga Steel & Iron Co., of Philadelphia, Pa., a concern taken over by the government for the war and engaged almost wholly in naval ordnance activity.

With cessation of hostilities and the practical abandonment of munition work, engineers are turning their attention to the use to which these furnaces can be put in industrial work.

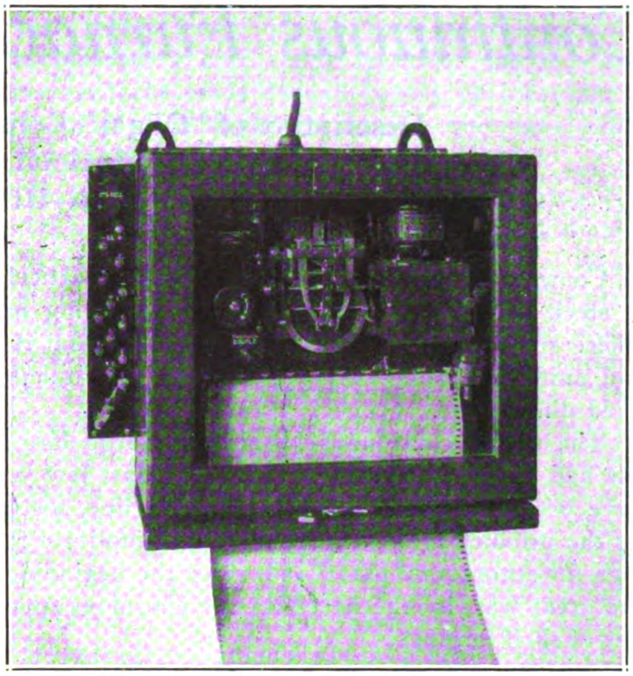


Fig. 4—Leeds & Northrup temperature recorder controller for controlling temperature at two points in an oven or furnace. Case closed.

There are a large number of heat-treating processes in the manufacturing industries requiring temperatures from 900 to 1,800 degrees F. Chief among these may be mentioned drawing and annealing carbon steel, drawing high speed steels, annealing brass and copper, and baking vitrous enamels.

The advantages of electrically heated furnaces constructed and equipped with heating units and temperature control systems as described, are automatic control of the temperature, minimum temperature variation in the furnace, maximum rate of heating the charge, uniform heating throughout the charge, maximum efficiency in heat treating, elimination of scale due to oxidation, duplicate results day after day, and elimination of combustion methods with their attendant uncertainty of results and general fuel problems.

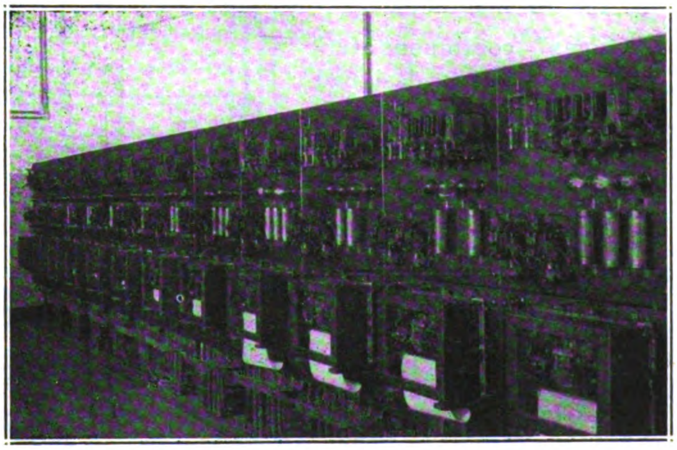


Fig. 5—Automatic panels and control instruments at the Tiogo Steel & Iron Co., Philadelphia, Pa., for large furnaces heat treating gun forgings.

Continuous Furnace for Heating Forgings

Description of "Oilgas" Continuous Furnaces for Drop Forgings. Uniform Heating, Maximum Economy and Constant Production Claimed as Advantages—Utilizing Liquid Fuel in Gaseous Form.

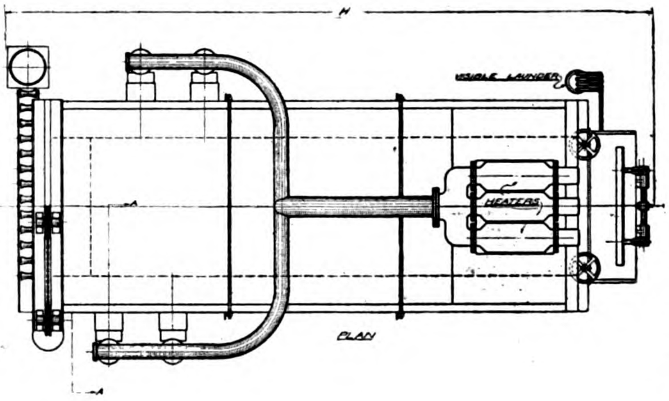
Continuous furnaces for heating metals, particularly steel, have had a wide application in rolling mills where speed and continuity of product demand rapid and uniform heating of ingots, blooms and billets of fixed dimensions.

The use of continuous furnaces for drop forgings has had a slower development, but the past few years have witnessed rapid strides along this line, fostered by the production of large numbers of duplicate forgings for automotive parts, and, since the beginning of the great war, by the necessity for enormous quantities of shell forgings.

Continuous forge furnaces, as the term is here used, refers to furnaces in which cold stock of uniform dimensions is introduced at the charging door and gradually advanced through a preheating zone to a final heating or soaking section from which it is delivered to the forging machine or hammer.

The advantages of this type of furnace are:

1. Uniform heating. The shock of subjecting cold stock to a very high temperature is entirely avoided.
2. Maximum economy. A large portion of heat from the combustion zone, otherwise wasted, is absorbed by the stock in the preheating zone.



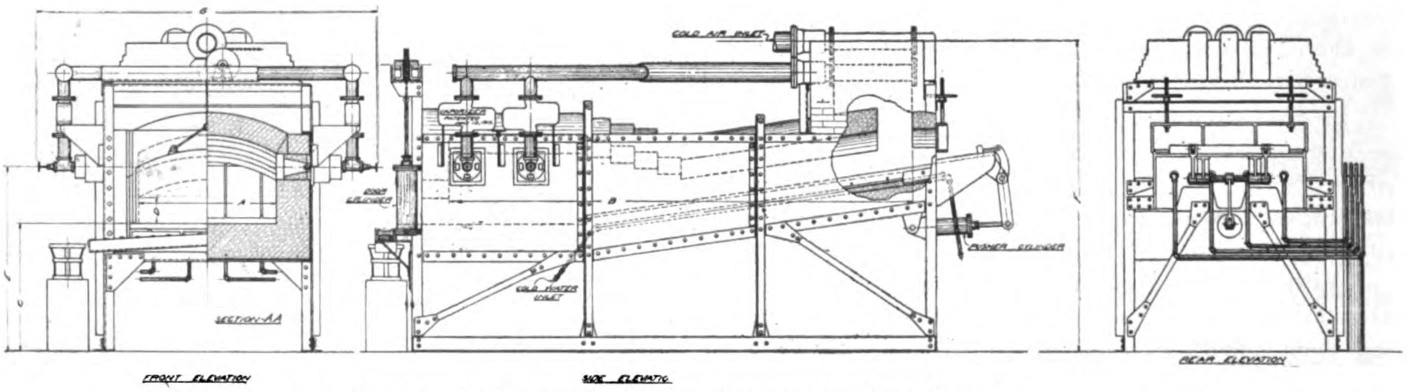
3. Constant production. A schedule of regular furnace output, limited only by capacity of forging machinery, can be maintained.

"Oilgas" continuous furnaces are always designed to suit the requirements of the particular duty they will be called on to perform. The furnace proper is liberally supplied with structural steel buckstays, and longitudinal binders are used to take unusual pressures such as those from arches. Buckstays are held by tie rods at bottom and top. To equalize various degrees of expansion and contraction, tie rods on furnaces having roof arches over 6 feet wide are provided with heavy spiral springs. Doors are heavy castings and furnished with inclined jambs, where desirable. Counterbalanced levers with pull chains are furnished for operating doors by hand, or electric, hydraulic, or air power is used, as conditions demand.

The special feature of these furnaces is the unique system of utilizing liquid fuel solely in gaseous form. Heaters or recuperators are placed in the path of the waste gases from the furnace for the purpose of preheating the blast. All the air required for combustion is contained in a closed low pressure system of piping and passes through the heaters to the vaporizers located in proximity to the nozzles.

The hot blast through the vaporizers comes in contact with the fuel which is admitted just under the air inlet and transforms the liquid into a gas providing all the advantages of natural gas with complete control of the quality of the heating flames. The fuel and air enter the furnace heated, intimately mixed and ready for instant combustion.

It will be noted that this system increases operating efficiency owing to the fact that the heat of the off gases, wasted in ordinary furnaces is absorbed by



Layout of "Oilgas" continuous furnace for drop forgings.

the air passing through the recuperators and is returned to the furnace; also for the reason that oxygen required for complete combustion may be supplied by the minimum amount of air because the fuel oil has been converted into a gas and an intimate molecular mixture of air and 'oilgas' is obtained. This avoids the losses incident to the heating of excess air, which, in ordinary furnaces, are frequently serious though seldom fully appreciated.

These features are fully covered by United States and foreign patents.

High temperaturs are readily obtained in 'oilgas' furnaces, and on this account, together with the ease of perfect control, they are especially adapted for heating stock for all forging and welding work and for piercing operations in the manufacture of tubes, seamless containers, etc., where temperatures are required much higher than for rolling mill practice.

The most common form of continuous forge furnace has an inclined hearth, over which the stock is rolled or pushed, depending upon its shape. If stock is of rectangular section, skid rails must be provided to protect furnace bottoms from abrasion, but rails of some character are usually provided to permit circulation of heat on all sides of stock. It is customary to provide a horizontal hearth section near the discharge end of the furnace where the stock may be separated for a few minutes of final soaking heat. The skid rails terminate at the edge of the soaking hearth, which is slightly lower than the ends of the rails, so that stock may be easily manipulated to insure uniform heat absorption.

When heating stock which is not of uniform section, such as cultivator shovels, plowshares, truncated conical forms, etc., a rotary hearth furnace provides all the advantages of the ordinary continuous furnace. Any shape of stock, singly, in piles or bundles, may be placed on the slowly revolving hearth, gradually heated, and removed near the charging point. This type of furnace is particularly valuable since there is no possibility of stock sticking together, and each piece receives precisely the same treatment. Further, the speed of the hearth may be adjusted and the production scheduled to suit conditions. Mechanical means may be provided for charging the furnace and for delivering heated stock to forging machines or wherever required, and when stock is heavy such facilities are necessary to speed up production and to reduce labor cost. Stock is frequently conveyed to charging door by means of jib cranes, monorail trolleys, or electric traveling cranes using electric magnets. Another expedient which saves rehandling is to load stock onto a transfer car and place between furnace and pusher for charging into the furnace.

Feeding devices for stock include simple compressed air, hydraulic cylinders or electric motor operated pushers.

Heated stock may be delivered by trolley, crane or automatically discharged to roller tables. The provisions to be made depend largely on local conditions. Study calculated to develop the most practical means for handling is well worth while.

The General Combustion Company has introduced a most successful and practical design for skid rails for which a patent has been secured. A steel wearing strip is clamped into cast iron saddles. The steel bar has minimum obstruction for passage of stock, high melting point, and provides minimum surface exposed to oxidizing influences in the furnace. The function of the cast iron saddles of large area is to carry away the heat just fast enough to prevent destruction of the steel skid bars. These rails are highly heat resisting and free from tendency to warp. When used in high temperature work they are further protected by a cooling pipe of ordinary gauge, placed beneath the cast iron saddles. This construction practically eliminates all skid pipe troubles including cold spotting.

The process herein described is particularly adapted to continuous furnaces, since it provides as high temperatures as may be required in the combustion zone, at the same time maintaining a non-oxidizing atmosphere within the furnace. The recovery of waste heat from the gases after passing over and preheating the stock, is very thorough, due to scientific design and arrangement of the recuperators. The return of this heat to the furnace as hot combustion air, provides a ready means of vaporizing or gasifying any liquid fuel so that a gaseous mixture of fuel and air is provided, hot and ready to burn on entering the combustion chamber. The entire absence of oil in the furnace is evidenced by the color of the flame, absence of scale, long life of refractories and extremely rapid heating.

The truly gaseous nature of "oilgas" may also be easily observed in a furnace operation. The fuel supply may be readily adjusted to give a strictly flameless and chemically correct combustion, under which condition no flame of any sort whatever is evident in the combustion zone, every brick becoming distinctly visible and the entire chamber a mass of heat, energy radiating from every minute point of combustion, as well as from every heated surface. Thus direct heating by radiation is accomplished without loss by cloud effects of visible flame, and without retardation of combustion by dilution with burned gases.

Since the liquid fuel is changed to a gas before entering the furnace, it is obvious that any "oilgas" furnace is essentially a gas furnace, and provides the most efficient means yet produced to utilize gas as well as oil as fuel. No change in design is required to burn gas in "oilgas" furnaces; in fact, both oil and gas may be used simultaneously in the same nozzle.

Overall thermal efficiencies as high as 60 per cent have been obtained in continuous forge furnaces of the type herein described when heating stock to 2,200° F.

Assuming fuel oil at 4 cents per gallon of 150,000 Btu, various heat sources would have to sell at the following prices to equal oil fuel as used in "oilgas" furnaces.

(1) Stoker fired coal of 12,000 Btu per pound, at 300 pounds per ton of steel heated, must sell for 12 cents per ton, allowing $2 per ton of coal for all labor charges.

(2) Powdered coal of 12,000 Btu per pound, at 250 pounds per ton of steel heated, must sell for 9 cents per ton, allowing $2.50 per ton of coal for all labor, handling, crushing, drying, shrinkage and investment.

(3) Natural gas of 900 Btu per cu. ft. must sell for 24 cents per 1,000 cu. ft. In any other non-regenerative furnace, not more than 16 cents per 1,000 cu. ft.

(4) City gas of 550 Btu per cu. ft. in an "oil gas" furnace must sell for 14.7 cents per 1,000 cu. ft. In any other non-regenerative furnace, not more than 9.8 cents per 1,000 cu. ft.

(5) Electricity at 80 per cent thermal efficiency of furnace $.0012 per kilowatt hour.

It is evident that oil will remain the ideal metallurgical fuel for many years or until the relative cost of oil over coal becomes far greater than at present.

Phosphorus Estimation in High Speed Steel

Difficulties Encountered in Determining Phosphorus in the Presence of Tungsten—Common Error Causes Less Phosphorus to Be Found than Is Really Present—Accurate Method Explained.

By G. W. GRAY and JAMES SMITH.

In view of the large amount of tungsten used in the manufacture of high-speed steel, the question of the estimation of phosphorus in the presence of tungsten is an important one, but, although important, does not appear to have had the attention it deserves. Judging from numerous analyses which have come under the authors' notice, many chemists seem to find less phosphorus than is actually present. On investigating the cause of the low results, they were found due to faulty methods. Taking ferro-tungsten as an example, the authors found that the method adopted by many chemists was to decompose the ferro-tungsten by fusion or other methods, separate the tungsitic acid by evaporating to dryness with hydrochloric acid, and estimate the phosphorus in the filtrate. This method is altogether wrong, as a large amount of the phosphorus present is precipitated with the tungstic acid as phospho-tungistic acid, and the phosphorus so precipitated is lost. Most ferro-tungstens contain only 0.15 to 0.30 per cent phosphorus, and with these the error is perhaps not quite so glaring, but odd samples made from phosphoric tungsten ores contain up to 0.100 per cent, and sometimes even more. It is in these high phosphoric samples that the error stands out prominently. The authors have seen samples containing 0.100 per cent phosphorus returned as containing 0.020 per cent. To illustrate this point a table of results obtained by using the faulty method described above is given, together with the figures obtained by further examining the residue of tungstic acid for phosphorus. These results are only a few selected from a large number of samples examined.

Sample No.	1	2	3	4	5	6
	%	%	%	%	%	%
Phosphorus in filtrate ...	0.023	0.017	0.022	0.014	0.017	0.013
Phosphorus in tungstic acid residue	0.057	0.071	0.080	0.055	0.032	0.020
Total phosphorus......	0.080	0.088	0.102	0.069	0.049	0.033

From the above table it will be seen that the larger proportion of the phosphorus contained in ferro-tungsten is precipitated with the tungstic acid, and any method of analysis which is based on separating the tungstic acid before estimating the phosphorus must give low results for phosphorus. It occurred to the authors that there might possibly be some definite ratio between the amount of phosphorus precipitated and the amount not precipitated, but after making numerous analyses of samples of ferro-tungsten it was concluded that there was no ratio, neither have they been able to determine the conditions necessary either to precipitate all the phosphorus with the tungstic acid or to precipitate the tungstic acid free from phosphorus. These low phosphorus results not only occur with ferro-tungsten, but also with tungsten ores. To quote one example out of many, a sample of wolfram which contained 0.200 per cent phosphorus was returned by one chemist as containing 0.030 per cent. The same state of things also obtains to some extent with tungsten steels—in fact, some tungsten steels when analyzed by the usual method show only a trace or no phosphorus at all, even when it is known that phosphorus is present. Indeed, it has been suggested that the phosphorus is slagged out in making tungsten steels because the amount of phosphorus in the ingredients used was so much higher than that found in the finished steel. It appears to the authors that the discrepancy is due not to slagging out the phosphorus, but to the whole of the phosphorus in the finished steel not being obtained in the analysis owing to the cause stated above.

The method devised by the authors for the estimation of phosphorus in ferro-tungsten, tungsten powder, and

(Continued on Page 356)

Paper read before British Iron and Steel Institute, May, 1919.

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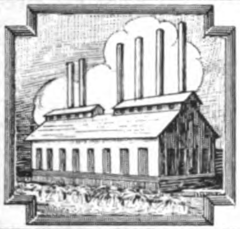
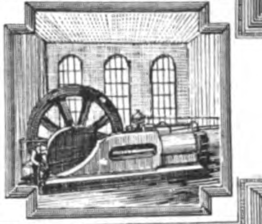


STEAM POWER DEPARTMENT



Combustion Control in Mill Boiler Plant

Losses Due to Presence of Hydrogen in Fuel, Visible Smoke and Radiation—Draft Gauge Important in Bringing About Efficient Boiler Operation.

By **ROBERT JUNE,**
Mechanical Engineer.

PART II.

"Boiler efficiency is a matter of public concern," stated a well known steel mill engineer at an informal gathering of engineers at the spring meeting of the A. S. M. E. in Detroit in June. "I have no more right to burn two tons of coal to do the work of one than I have to set fire to my house. It is against the public good. By wasting fuel I increase the cost of my own product, and I deprive some other manufacturer of the means of producing power to turn out his goods." The other engineers present agreed with this statement. Their attitude is typical of progressive thought in the iron and steel industry.

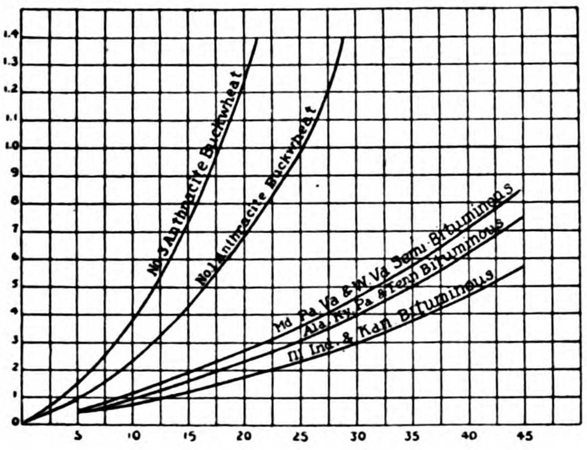


Fig. 1—**Different combustion rates for various fuels.**

In studying the problem of securing high boiler efficiency last month, we discussed certain of the heat losses occurring in combustion, such as loss in dry chimney gas, loss due to incomplete oxidation, loss of fuel through grate, and loss due to moisture in coal. In addition to these, there are certain other losses which should be noted.

Loss Due to Presence of Hydrogen in Fuel.

That part of the hydrogen in fuel, which is in a free state burns to water, and in so doing, liberates 62,000 Btu per pound. Unfortunately, all of this heat does not become available for producing steam, since the water formed by combustion is discharged by the flue gases as super-heated steam, at chimney temperature. This loss is inherent. With anthracite, it approximates 2.5 per cent of the heating value and with bituminous, 4.5 per cent.

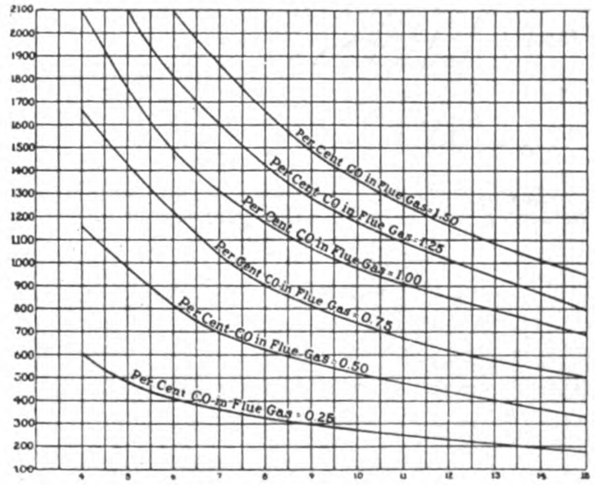


Fig. 2—**Loss due to unconsumed carbon contained in the CO in flue gas.**

Loss Due to Visible Smoke.

The loss due to smoke is very visible, but it cannot be weighed or measured, and is generally over-estimated. Smoke consists of carbon in a flocculent state, and ash mixed with the products of combustion.

The losses due to visible smoke seldom exceed 1 per cent. It must be remembered in considering this loss that a smoky chimney does not necessarily indicate an inefficient furnace. Paradoxical as it seems, a smoky chimney may be much more efficient than one which is smokeless; that is, a furnace operating with minimum air supply may cause dense clouds of smoke and still give a higher evaporation than one made smokeless by a large excess of air. There will, of course, be some loss due to carbon monoxide, unburned hydrocarbons, and combustible in soot in the former case, but this loss may be more than offset by the excessive losses caused by the heat carried away in the chimney gases in the latter. The amount of combustible in the soot and cinders deposited upon the tubes and in various parts of the setting, seldom exceeds 1 per cent of the calorific value of the fuel.

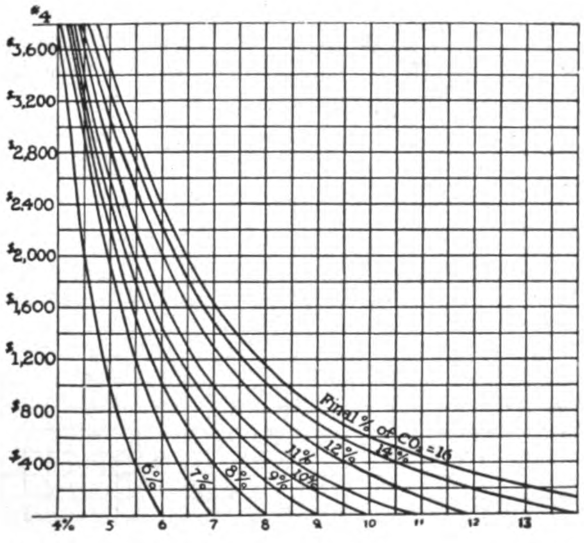


Fig. 3—Saving in dollar per year per 100 hp. by increasing the percentage of CO_2 in the flue gas, coal at $4 per ton.

Radiation and Unaccounted-for Losses.

These losses are determined by simple arithmetic, being the difference between the sum of the heat represented in the steam and the losses previously mentioned, subtracted from the 100 per cent total heating value in the fuel. Consequently, unless careful attention is given to accuracy of determination of other losses, the figures arrived at for this loss will be in error.

Radiation losses should not exceed 2 per cent, and, as a matter of fact, do not, with well-designed, well insulated boiler furnaces. On the contrary, with poorly installed settings, where insulation is not properly attended to, radiation losses may amount to as much as 6 to 8 per cent.

Table III.
Per Cent of Calorific Value of Coal as Fired.

Heat absorbed and losses itemized	Highest attainable efficiency	Excellent practice	Good practice	Average practice	Poor practice
Heat absorbed by boiler....	89.86	80.0	75.0	65.0	60.0
Loss due to free moisture on coal	0.50	0.5	0.6	0.6	0.7
Loss due to hydrogen in coal (evaporation of H_2O)	4.20	4.2	4.3	4.3	4.4
Loss due to heat in dry flue gases	5.33	10.0	13.0	17.5	20.0
Loss due to carbon monoxide	0.00	0.2	0.3	0.5	1.0
Loss due to combustible in ash and refuse	0.00	1.5	2.4	4.5	5.5
Loss due to heating moisture in air	0.11	0.2	0.2	0.3	0.4
Loss due to unconsumed hydrogen, hydrocarbon, radiation and unaccounted for	0.00	3.4	4.2	7.3	8.0
Calorific value of coal......	100%	100%	100%	100%	100%

It is undoubtedly true that this loss equals a full 4 to 6 per cent in the average plant ,and that it could be cut squarely in two with a comparatively small expenditure for insulating material.

The sum of all the losses and the heat absorbed by the boiler, when distributed in a table or on a graph, gives us the heat balance. As the operating engineer, when searching out means for the elimination of losses, is concerned with "coal as fired," any general representative heat balance, such as is shown in Table III, is of value for purposes of relative, but not absolute comparison.

The losses which have been considered, cover continuous operation of the boiler at normal or high rating. In addition there are other important sources of loss in operation, such as standby losses, blow-off losses, losses due to leaky traps, valves, etc. These will all be discussed later.

Draft Gauge Is the Fireman's Best Friend.

This statement is made with due consideration of all the factors entering into successful boiler operation. It enables the fireman to produce the largest amount of steam with the least amount of coal handling.

In bringing about efficient boiler operation, continual observation of what is being performed is absolutely necessary if highest practical efficiencies are to be obtained. For this reason boiler-room instruments are absolutely necessary.

The draft required to effect a given rate of combustion depends upon the kind and condition of fuel, the thickness of the fuel bed, type of grate and efficiency of combustion, and can only be found accurately by experiment. For every kind of fuel and rate of combustion, there is a certain draft with which the best results are obtained. The curves in Fig. 1, give the furnace draft necessary to burn various kinds of coal at the indicated rate of combustion for average operating conditions. These curves allow a safe margin for economically burning coals of the characters noted. Specific figures for the various type of stokers may be obtained from the manufacturers.

When combustion is progressing properly, the quantity of gases will be in direct proportion to the load. The boiler through which the gases pass has a constant resistance (constant, that is, for the individual boiler—different sizes and makes of boilers have different resistances). The function of the draft gauge is to indicate the difference in pressure between the point or points with which it is connected, and the atmosphere. A simple draft gauge is connected to one point, a differential to two.

A draft gauge connected to show the pressure drop through the fuel bed in connection with one showing the drop through the boiler will indicate any change in the conditions of the fuel bed. A relative increase in the drop through the fuel bed will indicate that the bed is becoming thicker, or that it is becoming clogged with clinkers, etc. If the pressure drop becomes less, it indicates that there are holes in the fire or that the fuel bed is too thin.

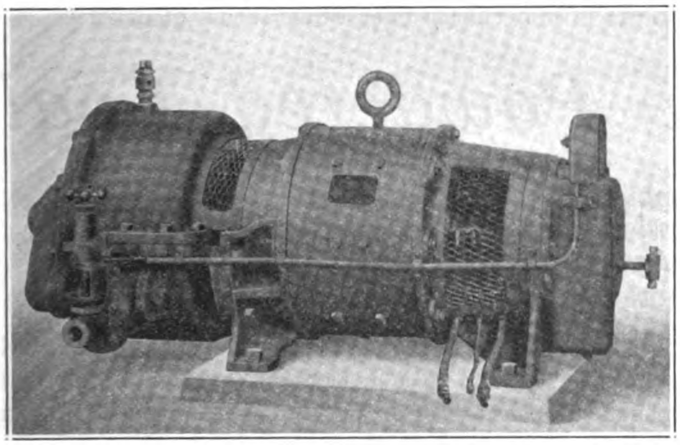
The pressure drop across the fire varies with the resistance of the fuel bed and also with the rate of flow of air through the fuel bed. The furnace indicator compares the pressure drop across the boiler, eliminating effects due to the rate of flow of air, and thus obtains a net result which varies only with the resistance of the fuel bed. While this type of apparatus indicates what is going on in the furnace boiler, the operator must have sufficient intelligence and skill to be able to interpret its indications and adjust conditions.

Small Turbine Application for Steel Mills

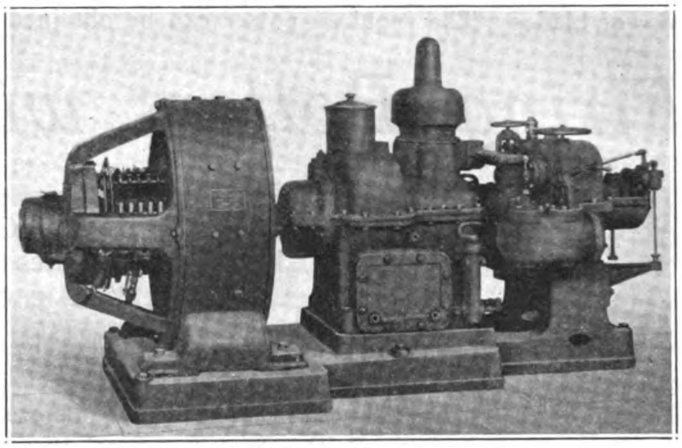
Ease of Operation, Small Floor Space, Continuity of Operation, Availability of Exhaust Steam are Chief Factors in Favor of Small Turbine Installations in Steel Plants.

By G. T. KEECH, JR.
Small turbine division, Westinghouse Electric & Manufac turing Co.

The fact that the small turbine, both direct connected and geared, so readily adapts itself to the many requirements for power around blast furnaces and steel mills, is causing operators and plant engineers to look with favor on the increasing number of such installations. By small turbines the writer means mechanical drives, both direct connected and geared, up to 1,000 horse power; and electrical drive, both condensing and non-condensing, up to 750 or 1,000 kilowatt.



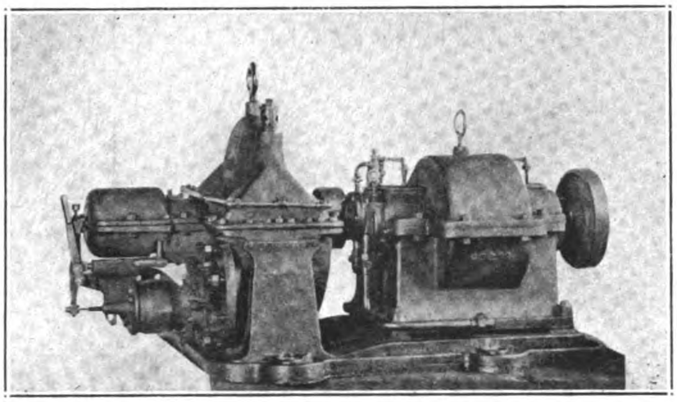
10 kilowatt turbine generator for lifting magnet work.



200 kilowatt direct current geared turbine generator unit.

The general points which have influenced the installation of small turbines over other forms of drive have been as follows: First, ease of operation and reduction of maintenance expenses; second, the turbine is smaller than a reciprocating engine and requires less floor space and lighter foundations; third, the absence of reciprocating parts permits of continuity of operation because the working parts are enclosed, keeping the grit and dirt always found around a steel mill from getting into it; fourth, the turbine is a prime mover, and as long as it is supplied with steam it will deliver its rated capacity; fifth, the steam from the turbine exhaust can be used for feed water heating or for heating buildings during the winter months, since it is free from oil.

Given the range of speed which the turbine or the turbine and gear has, it is very easy to apply the turturbine to a wide variety of conditions just as economically or more economically than any other type of prime mover. Using a specific example, a boiler feed pump is a very important auxiliary of a steel mill having its own power plant. Here the turbine has the advantage because of better overall economy, absence of reciprocating parts, ability to meet rapidly varying load conditions, low maintenance costs, absence of valve and rod packing troubles, freedom from grit and dirt in wearing parts, and finally, exhaust steam for feed water heating which is free from oil. The turbine selected should be of rugged frame construction and mounted on chairs or pedestals very near the center line of the shaft. The rotor should preferably be of the single wheel type with a single row of blades. The required power can be obtained from a single rotor by passing steam through the blades two or more times. In order to prevent steam leakage along the shaft a water sealed gland should be used. The governor should be rugged in construction, and an emergency overspeed governor should be demanded to protect the turbine in case the pump runner should break or the pump suddenly drop its load. For the same reasons as given above the turbine is just as suitable for driving condenser pumps, main circulating pumps and fire pumps.



Mechanical drive turbine and gear.

With respect to electric drive units, the entire line can most advantageously be taken care of by using a high speed turbine at its point of best economy, a double helical reduction gear and a moderate speed generator at its point of best efficiency. Such a line of units can be obtained from a 25 kilowatt exciter set up to a 1,000 kilowatt unit which could serve as a main generating unit for a moderate size steel mill. With this type of construction it is possible to place the governor on the slower speed gear shaft and thus obtain a mechanically stronger governor with its closer regulation.

A new line of small direct connected turbine generator units has recently been placed on the market in sizes ranging from 5 to 15 kilowatts. They are of particular interest to the steel mill operator and are intended to be placed on locomotive cranes to generate current for the lifting magnet, handling billets, pig iron and scrap iron more expeditiously and more economically than it can be handled by any other method. The labor saving of the lifting magnet is obvious.

The experience of turbine builders shows that the steel mill operator who is building a new plant or remodeling and repairing his old one, is taking advantage of turbines as prime movers, due to their general points of superiority over other forms of drive.

Firing Boilers with Powdered Coal

Essential to Provide Sufficient Combustion Area Per Pound of Coal Burned Per Unit Time, Otherwise Ash Is Not Deposited in Slag Chamber—Sketches of Approved Arrangements.

By L. C. HARVEY.

The author recently read a very comprehensive paper entitled "Use of Pulverized Coal, With Special Reference to Its Application in Metallurgy," before the May meeting of the British Iron and Steel Institute. From this paper the following extract, having reference to the use of pulverized coal under boilers has been taken.

This subject has been fully treated in the report submitted to the Director of Fuel Research, but it will not be out of place to record here the views of Prof. W. F. Durnand, Leland Stanford University, California:

"To obtain the best results in the furnace the coal should be ground to a degrees of fineness which will insure the passage of 95 per cent through a 100-mesh screen and 85 per cent through a 200-mesh screen.

"With coal thus prepared and with heating value 11,580 Btu, tests have shown an equivalent evaporation of 8.38 lbs. per pound of coal fired and of 10.9 lbs. per pound of combustible. With Texas lignite with a heating value of 11,250 Btu the results showed 7.26 lbs. per pound of coal fired and 8.81 per pound of combustible."

These remarks were made in relation to the possi-

bility of firing boilers with Texas lignite carrying as high as 20 per cent ash and 30 per cent moisture, and the results are indicative of what can be accomplished with low-grade fuels for this purpose.

In connection with copper-smelting furnaces, waste-heat boilers are invariably used, and it has been stated that, as compared with hand-fired furnaces, boiler tubes are cleaned no oftener when using pulverized coal than for hand-firing. The ash in the waste gases gives very little trouble, flue connections being cleaned out once a day. With certain coals less trouble has been experienced in cleaning away the ash in flues with a 20 per cent ash coal than with a coal containing only 9 per cent of ash but of a more fusible nature. Approximately 50 per cent of the total ash content remains in the furnace and is run off in the slag.

An illustration in the "Report" shows the arrangement of a Dutch oven built out in front of the boiler and the provision of slag chamber that is to be preferred in cases where an ash-pit of the design shown can be used. It is essential to provide a sufficient combustion area per pound of coal burned per minute or per hour, otherwise incomplete combustion results, and ash is not deposited in the slag chamber in the quantity required. An undesirable deposit will also be found on the boiler tubes, due to the partly burned particles of coal adhering to the tubes and fluxing thereon, and to the high velocity of gases through the restricted combustion chamber. This results in the carrying over of an undue proportion of the ash.

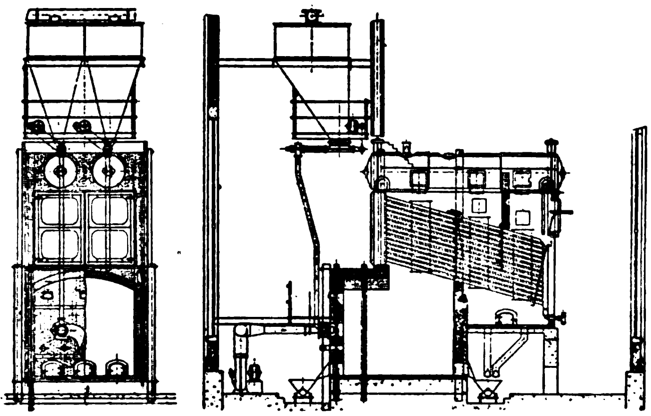


Fig. 1—500 HP Babcock & Wilcox boiler, arranged for firing with pulverized coal.

With correct combustion space and low velocity of gases readily fusible ash is deposited in the slag chamber, and the fine more or less infusible particles float through the boiler tubes and boiler passes.

In cases where it is impossible to excavate under the boiler setting to provide for the slag chamber, or for the ash tunnel, an extended Dutch oven must be employed to obtain the required minimum combustion area.

The ideal conditions exist, of course, when a new plant is to be designed. Fig. 1 shows the latest approved arrangement. All burner and air-supply piping is out of the way in the ash tunnel, and ample provision can be allowed for the ready handling of the slag deposit and fine dust removal.

Applications to Lancashire boilers are not so easily carried out when space in front of the boiler is limited. A suitable arrangement, having in mind the essential points mentioned above, would be that shown in Fig. 2.

The ideal arrangement would be to have a deep and narrow combustion chamber in front of the boiler with a burner at each end, but Lancashire settings are as a rule so close that this method cannot be adopted.

Waste-Heat Boilers.

The application of powdered fuel to high-temperature furnaces, open-hearth melting, puddling, forging and welding, billet-heating furnaces, with the exception of those of the continuous type, and cement kilns makes it possible to instal waste-heat boilers with great advantage. The temperature variation in such furnaces is very small, comparing favourably in this respect with the uniform temperatures obtainable with gas and oil firing. The fine unfused ash dust passing into the boiler from the furnace causes very little inconvenience.

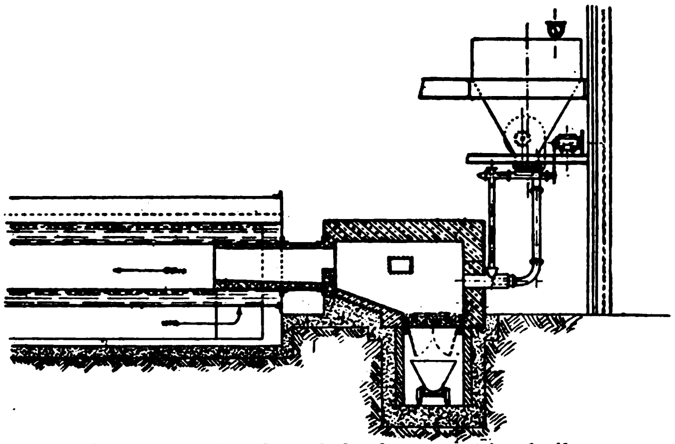


Fig. 2—Powdered coal fired Lancashire boiler.

The utilization of waste heat from metallurgical furnaces was very fully dealt with by T. B. Mackenzie* at the last meeting of the institute, and heat balance sheets and results of tests will be found in his paper. A. D. Pratt† has also recorded the results of tests of waste-heat boilers attached to open hearth furnaces.

By the use of a supplementary burner fitted at the uptake to the boiler, steady steaming at full rated output can be obtained, thus removing the usual objection to this type of steam supply plant.

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*Journal of the Iron and Steel Institute, 1918, No. II, page 139.

†Journal of the American Society of Mechanical Engineers, December 6, 1916.

FOREIGN RELATIONS

AMERICAN PARTICIPATION IN CHINA DEVELOPMENT.

By Paul P. Whitham, U. S. Trade Commissioner.

A great opportunity awaits American capital and enterprise in China. The Chinese people for a long time have been most friendly to the Americans, but a unique situation now exists. America is regarded as the chief force that brought about victory. Our country is regarded as being the most powerful and the wealthiest nation in the world today. Furthermore, it is the common belief that America has no political or territorial designs upon China; consequently, the Chinese are urging, in fact expecting, the assistance of American capital and leadership in the economic transportational and industrial reconstruction and development of their country.

After nearly two years of travel and investigation in China, I am not so much troubled about finding opportunities for Americans in China, as I am concerned about the attitude of American business and financial houses toward those opportunities. Too often the average American house seems to have its purposes centered in the "immediate transaction" and the quickest profits. It does not appear to possess an appreciation of a business career extending over a long term of years. It does not show evidence of a national sense that considers the nation's well-being in relation to the up-building of a permanent foreign trade structure that will enhance the country's wealth and prestige during the future years.

The "slap-dash American business man" has been in China, but he has left more wrecks perhaps than successes or he has taken the largest possible immediate profit and departed. It is not intended to cast reflection on American business enterprises in China. There are a few houses that are painstakingly developing solid business in the Far East, but on the whole America has only nibbled at the great constructive opportunities that are being thrust upon her by the Chinese. America has played and is yet playing only an insignificant roll in the economic, transportational and industrial reconstruction of a great country, a nation that has an essentially sound and industrious man power, three to four times as numerous as America's.

Apparently this fact has been overlooked by our business and financial houses.

Americans must make heavy investments in the economic and industrial reconstruction of China as the foundation upon which to build a large, permanent and lucrative trade.

Investments may pay only a moderate rate of interest, but they will develop China and multiply many times the producing and purchasing power of her 300,000,000 or 400,000,000 people, making possible the gathering in of the real profits through the expansion of general trade. Investments of this character will enhance American prestige and make her an influence and power in China and the Far East.

The world has need of the things the great continent of Asia can be made to produce. It is important that the enormous potential man power of China be directed to constructive work that will enrich the Chinese and add to the wealth of the world. It would appear that the most effective way to lighten the tremendous war debts is to go out into the unused and backward places of the world and create new wealth on a scale not deemed possible heretofore.

America needs houses that are willing to "sacrifice a per cent" in order to build up a future for themselves and their nation.

America needs pioneers, men with iron in their blood dominated by a vision that will inspire them to go forth into the world and duplicate the deeds of those who lead in the development of the American continent.

America having in a measure completed the big task of subduing a continent within her own borders, needs to become a world pioneer, taking on yet greater tasks lest she soften and deteriorate amid the affluence and comfort of her own pleasant land.

The world needs America's energy, material power and moral force applied to the vast unused places of the earth and to the backward countries bordering the Pacific in order that new wealth may be created, that the principles of liberty, equal opportunity and peace for which the war was fought and won may be made to prevail.

America, quite naturally, perhaps, has been self centered, preoccupied as she was with her own internal development. The development of her own great country was necessary not as an end in itself, but was a foundation upon which the nation might base activities extending throughout the world. Our people came dangerously near making this internal development the chief aim and national purpose. History shows that such a course in the end is fatal. The ingrowing nation eventually weakens and dies just as the man who makes his education and physical development an end in itself, but fails to actively assume the responsibilities and obligations of the larger life outside of himself, is doomed.

Fortunately the war shook America out of her self-centered life before the ingrowing tendency had seriously weakened the national fiber. Americans are now viewing the world as their sphere. They are beginning to comprehend something of the great opportunities for constructive effort that will enrich them; of the service that will be its own reward; of obligations to mankind that must be assumed lest the future existence of their own country be threatened.

In conclusion: This is the day of America's great opportunity in China and the Far East. If it be taken at high tide, America will gain a great and profitable business in the Orient. If it is allowed to slip by history is not likely to repeat itself.

COAL AND IRON MINES AND STEEL WORKS OF FRANCE AND BELGIUM.

Frank H. Probert, consulting engineer of the Bureau of Mines, Department of the Interior, and dean of the College of Mining, University of California, member of a special American Commission to investigate the damage done by the Germans during the war to the coal and iron mines and steel works of France and Belgium, after a personal investigation, returned to Washington with a first-hand story of the almost unbelievable atrocities of the Hun in the destruction and wreckage of the industrial life of France and Belgium. Mr. Probert, together with Dr. F. G. Cottrell, chief metallurgist of the Bureau of Mines, and George S. Rice, the chief mining engineer, made up the American mission sent to Europe last January on the invitation of the French High Commission. The purpose of this mission was not only to investigate the damage done but to advise with the foreign officials concerning reconstruction and rehabilitation and assist in any way possible on matters pertaining to the mineral industry.

Mr. Probert visited the iron mines of Nancy, Briey, Longwy, and Luxemburg; coal mines in the Province of Saar, and the coal district of Pas de Calais. Details of the investigation will be published in an official bulletin of the Bureau of Mines within the next months, until which time, no detailed statement is permissible. Letters of introduction from M. Loucheur, Minister of Industrial Reconstruction in France, assured the mission proper recognition, and every facility to expedite the work was given by the French government officials. On instructions cabled by Secretary of War Baker to General Pershing, rapid transportation was arranged and such other assistance as needed was placed at the disposal of the representatives of the Bureau of Mines. In no other way would it have been possible in so short a time to get as comprehensive an insight into the present-day condition of the mining industry of the Western front.

Mr. Probert, in a preliminary report to Van. H. Manning, Director of the Bureau of Mines, has the following to say:

"Early in the war the German hordes swept southwest through the iron basins of French Alsace and Lorraine, and for nearly four years this renowned mining area was held and exploited by the invaders. Many of the employes were made captives and compelled to work in the mines under German direction. The international boundary between France and Germany was drawn in 1871, to give the victor of the Franco-Prussian war control of the iron fields, but since that time scientific development, guided by a better understanding of the local geology, exposed for France a greater ore reserve at lower horizons than that of Lorraine Annexee. With the return of Alsace and Lorraine to the mother land, France will become the dominant factor in the future steel industry of Europe. During the German occupation, the iron mines were not intensively exploited because of the necessity of recruiting into the Teuton army every able bodied man and on account of the large accumulation of war minerals in preparation for the war. The actual physical damage to the iron mines is relatively small when compared with the destruction of the coal fields of northern France, which was as reprehensible as it was complete. Only in a few cases, where pillars have been robbed, is there any collapse of underground workings in the iron mines, but the equipment, both surface and underground, has been misused, and where ore has been mined, the lack of development will defer realization of capital until the exploratory work is sufficiently advanced to admit of daily output approximating pre-war conditions. The mines are not seriously crippled but what of the steel plants in which the iron ores are smelted? No such atrocity was ever perpetrated against the industrial life of any country. Magnificent plants, comparing favorably with anything we have in the United States, are now but a tangled, twisted mass of structural steel and broken stone. The wilful demolition was scientifically planned and systematically carried out. This after the removal of all such mechanical and electrical power units as could be used in Germany. The maliciousness and efficiency with which this crime against French industry was conducted is almost unbelievable.

"In the coal districts of Pas de Calais and Nord, a sector fought over from the beginning to the end of the war, changing hands frequently, bombarded all the time, all surface structures whether of town, village or mining enterprise have been razed. This may be legitimate warfare, but now that the guns are silenced and the frenzy of combat is past, it is horrible to look upon. Arras, Douai, Bethune, Bapaume, Lens, Loos, Courrier, centers of coal-mining activity but a few years ago and the mainspring of French industrial life, are gone, but the indomitable spirit of France survives and already plans are laid for the future. Bruay, at the western edge of the known coal field, was not in the fighting zone and its output has been steadily maintained, but going eastward the frightfulness is more and more appalling, for the hate of the Hun left its mark on the mines during his forced retreat. The coal measures are overlain by water-bearing strata, necessitating special methods of shaft sinking and support to keep the mines dry. The steel lining of the shafts was dynamited, letting in the quicksands and flooding the underground working for many miles. In the entire Pas de Calais region it is estimated that 120,000,000 cubic meters of water must be pumped before mining operations are resumed. Having flooded the mines, the headframes and surface equipment were systematically dynamited, the twisted debris in many cases filling up the demolished shafts. It will probably be five years before this coal district can be rehabilitated and 12 to 15 years before it gets back to normal pre-war output. The first great need is for buildings in which to house the workmen."

The Saar coal fields were visited by the Bureau of Mines officials. Here, in striking contrast to the mining districts of France and Belgium, the coal industry is at its height.

"It would be presumption on the part of an American mining engineer to suggest improvements in methods or practice in French mining. The French engineers have long known their own problems and have solved them in accordance with their system of finance and amortization. Their mines are developed and equipped with the idea of permanent industry and unless there is serious labor unrest and extraordinary advances in wage scales, the old French practice is peculiarly suited to French conditions. Their policy is progressive. There is constant search for new mineral areas or extension of proven deposits. French Lorraine has greater iron ore reserves than those of Lorraine Annexee, and just before the outbreak of war, drill holes had shown the extension of the coal measures of Pas de Calais to the south. Iron and coal are complementary minerals. France has them both in larger quantity than in 1914, and when her reconstruction program is carried out, the steel industry will be among the first assets of a land that has suffered greatly."

SOME PHASES OF WHAT IS CALLED RECONSTRUCTION.

I have ventured to make the subject of this address "Some Phases of What Is Called Reconstruction," because I wish to separate as different, both in kind and degree, the task we have of readjusting ourselves to peace conditions after the confusion and turmoil of war from European problems arising from the same cause, and also to suggest what it is among us that really needs reconstruction and is proceeding somewhat more rapidly than is supposed to get it.

Problems of Physial Reconstruction of Foreign Industries.

The problems with which the United States has to deal differ both in kind and degree from those which trouble Europe. The great industrial district of Belgium and northern France were not only overrun, but ravaged. In some part the industrial buildings were destroyed; in larger part the equipment was stolen; in complete degree the materials and finished products were taken. The manufacturer of those countries, as he goes back to the site where his industry once flourished, finds no materials with which to work, no stocks from whose sale he may recoup his weakened finances, sometimes no machinery with which to work, sometimes no factory to contain his machinery. Let us suppose, however, that he is so fortunate as to have buildings and equipment ready to his hand, or that in the few months that have passed since military operations ended, he has been able, in one or another way, to procure them—how shall he get to work? Materials are not available. Credits are not sufficient. His force has been broken up; many of his workmen slain or maimed; others dispersed. Here is a task of true reconstruction, physical rehabilitation. Patiently he must find means for credit, secure materials, reorganize his force, hunt up former customers, restore old avenues of trade, and he will do well if he is fairly running on his new course by the time a year has elapsed from the armistice. It is likely to be two full years before anything like normal conditions return.

The manufacturer in Great Britain is not in quite so hard a case, for his factory is physically intact. It may, indeed, have been made over for war purposes and require renewal and rearrangement ere it can readily serve the needs of peace. His plant may have been diverted from its original purpose, and he may have been caused to specialize in lines with which, before the war, he was unfamiliar. As all these manufacturers, however, look out into the New World they find one change so radical that it alters their entire relations to commerce, whether domestic or foreign, of which they are a part. This is the extraordinary advance in wages. From German sources comes the statement that labor costs in that country have multiplied by three and fuel costs by six. This is, of course, measured in their depreciated currency; but that very depreciation makes it doubly difficult for them to procure their supplies of raw materials save at onerous prices.

From address by Hon. William C. Redfield, Secretary of Commerce, before the Cleveland Advertising Club, Cleveland, O., June 11, 1919.

PRODUCTION TOPICS

POWER TRANSMISSION

R. W. Wilbraham brought out an interesting point in discussing a paper read before the Philadelphia section of the A. I. S. E. E., by H. B. Vincent, entitled, "Power Transmission." Mr. Wilbraham referring to some practices being used in maintaining service to the steel and allied industries in the vicinity of Chicago, Ill., and Hammond, Ind., said:

"Lines originally built for 11,000 volt transmission purposes in a very short time developed into distribution lines due to the rapid growth of the industries. Naturally very many disconnecting switches were necessary for sectionalizing, tying in between trunk and feeder lines, and for disconnecting the customers' equipment, the majority of which were mounted on the cross-arms and operated by a switch hook. You will readily appreciate that in case of trouble, particularly at night, the load dispatcher encountered a great deal of trouble in explaining to the linemen over the telephone the proper switches that should be operated in order to restore service over any circuit. Misunderstandings of orders arose on a number of occasions resulting in serious shutdowns to a number of steel plants. A scheme was then worked out in connection with the pin-board (that has been explained by Mr. Vincent) whereby each disconnecting switch on a line, or between lines, was given a number, starting with the first switch in the line as No. 1 and numbering consecutively to the end. Where the line was designated by a number, the first figure of the disconnecting switch number was the number of the line, and the remaining figures the number of the switch on that line, i. e., switches No. 510 or 602 would be respectively, No. 10 switch on No. 5 line, and No. 2 switch on No. 6 line. The switches were numbered in terms of hundreds for the reason that it would allow for the numbering of 99 switches, whereas, if they were numbered in tens it would only allow for the numbering of nine switches, and a line of any size will contain more than nine switches.

"These numbers were then marked on the pin-board and the corresponding number in blue and white enameled steel figures was attached to the cross-arm immediately under the switch. In order to determine quickly the location of the switches, all trouble men were equipped with a location list of switches arranged in numerical order and placed in a folder with a transparent celluloid cover. This, therefore, made it possible for the load dispatcher, after the trouble had been located, to properly direct the trouble man, it being only necessary to give him the number of the switches and the sequence in which they were to be operated if such was ncessary.

"Furthermore, inasmuch as the general line foreman, load dispatcher, and the various plant and substation operators were furnished with pin-boards it made it possible for the load dispatcher to advise all these men as to switch changes, and to be sure that serious errors were not made as under the old system. This system has been in force now for several years and has been found to be entirely satisfactory, both from the point of identification as well as minimizing interruptions."

ANDREWS STEEL COMPANY EXTENSION.

The S. R. Smythe Company, of Pittsburgh, Pa., has recently completed a contract with the Andrews Steel Company, of Newport, Ky., as consulting and contracting engineers, and prepared all drawings and built an extension to their steel plant, this being the third contract the first named company has performed for the Andrews Steel Company. The work comprised and included the excavations, foundations, two 100-ton basic open hearth furnaces, charging floor, buildings, storage bins, mechanical gas producer plant, consisting of five Morgan mechanical producers, ash and coal handling equipment, rearrangement of all railroad and stock tracks, etc., complete. The extension has been completed and is now in operation.

The S. R. Smythe Company has also completed for the same company a complete rearrangement of the gas producer plant for blooming mill soaking pits, whereby the gas has been changed from an underground system to an overhead system, whereby the gas is conveyed from producers entirely over the top of the blooming mill building with proper downtakes, headers and connections, embodying quite a few new features as to soot catchers and insulation.

New soaking pit furnaces have been built along patented ideas of H. E. Smythe, whereby the pit furnaces have no checkers for the gas, but arranged for checkers in the air chambers only. The result is a milder heat with less oxidation and operating with about one-third less gas, the pits are absolutely under control, are and have been in operation with the most economical and satisfactory results and tonnage output, and quality of steel being increased materially.

PHOSPHORUS ESTIMATION IN HIGH SPEED STEEL.

(Continued from Page 348)

tungsten ores, which has proved to be an accurate one after some years of service, is as follows:

Fuse two grammes of the finely powdered sample with 10 grammes nitre mixture (Na_2CO_3 + KNO_3 in molecular proportions) in a large covered platinum crucible, dissolve the melt in the least possible quantity of water, filter, and wash free from tungstates with boiling water containing a little ammonium nitrate (six washings are sufficient). Ignite the residue in the original crucible, transfer to a 400 cubic centimeter beaker, dissolve in hydrochloric acid, and evaporate to dryness. To the filtrate add 20 cubic centimeters hydrochloric acid, and about two cubic centimeters bromine (bromine, not bromine water), stir well until the liquid is distinctly colored by bromine, add ammonia until the precipitated tungstic acid is dissolved, and then a further quantity of strong ammonia equal to one-fourth of the original bulk of the liquid. The volume of the liquid should now be about 250 cubic centimeters. Cool and add three cubic centimeters magnesite mixture, stir well, and allow to stand for six hours, or preferably over night. It is generally supposed that ammonium magnesium phosphate is much more soluble than it really is. The authors found that under the conditions described, the phosphorus is completely precipitated by magnesia mixture.

Filter through double papers and wash six times with ammonia water (10 per cent). Dissolve the precipitate in hydrochloric acid, allowing the liquid to run into the beaker containing the iron, evaporate to dryness, take up with 10 cubic centimeters hydrochloric acid, dilute, saturate with sulphureted hydrogen to remove arsenic, tin, etc.; filter, wash, boil off sulphureted hydrogen, add 50 cubic centimeters ferric chloride (one gramme pure iron dissolved in hydrochloric acid, oxidized with nitric acid and made up to one liter), cool completely, add ammonia until a distinct dirty green precipitate is obtained, then acetic acid until the precipitate is obtained, then acetic acid until the precipitated ferrous hydrate is dissolved, boil well, and filter off the basic ferric acetate which contains all the phosphorus, dissolve in hydrochloric acid, boil, add a few cubic centimeters nitric acid and precipitate with ammonia. Boil, filter, wash, dissolve in nitric acid, and precipitate the phosphoric acid with ammonium molybdate as usual.

The method may also be used for the estimation of phosphorus in alloy steel, but as steel cannot be fused directly with niter mixture it should be dissolved in nitric acid in a dish or wide beaker, evaporated to dryness, and baked on a hot plate until the nitrate of iron is decomposed to oxide. The resulting oxide of iron, etc., can then be easily and cleanly removed from the dish or beaker with the aid of a flexible spatula and wiping with a little damp filter paper. It is then fused with niter mixture and the analysis proceeded with as directed for ferro-tungsten. The method is especially useful for vanadium (which interferes very considerably with the estimation of phosphorus by the molybdate method) is completely got rid of before precipitating with molybdate.

The authors have submitted the method to chemists in several large steel works, who have found it satisfactory.

NEWS OF THE PLANTS

The Lake Huron Steel Corporation, Goderich, Ont., Can., recently organized with a capital of $15,000,000, is planning for the erection of a local plant for the manufacture of high carbon steel. The company has secured a site of about 1,000 acres in Goderich township, and the proposed plant will produce material for use in the manufacture of automobiles, tractors, trucks, and kindred equipment. The company will secure its ore from the Lake Michigan and Lake Superior districts. To provide operation at the works, it is understood that a hydro-electric power plant will be established, with a capacity of about 25,000 horsepower, and with transmission line reaching to the site. H. B. McCreath, Toronto, and associates, are interested in the ne worganization.

The Milliken Brothers Manufacturing Company, Inc., Woolworth Building, New York, is now operating it at its new plant at One Hundred and Thirty-sixth street and the East River, for the production of steel transmission towers, steel radio towers, special pinlock poles, and structural steel buildings, known as Milliken Buildings. The company has plans under way for the establishment of a large galvanizing plant to be provided with equipment for the handling of large and small structural shapes and other steel work to be exposed to the elements; this plant will be one of the largest works of its kind in this section. To provide for export business, the company has organized the Milliken Manufacturing Syndicate, Ltd., London, Eng., and established offices at the Amberley House, Norfolk street, Strand, with F. Sumner Smith, formerly managing director of the British Electric Equipment Company, Ltd., and C. T. Wilkinson, previously associated as London representative for Milliken Brothers, Inc., and which concern has now been absorbed by the Milliken Brothers Manufacturing Company, Inc., in charge. Arrangements have been perfected with the Widnes Foundry Company, Ltd., Widnes, Lancashire, to operate a department of its works for the production of the different specialties. This local manufacture will provide for sales throughout Great Britain, British Colonies, and European countries. South American trade will be handled from the New York office. To provide for Western business, a branch office has been established in the Majestic Building, Chicago, and extensive plans have been developed for the sale of the different commodities throughout this section. To look after the Pacific Coast trade, offices have been located in the Rialto Building, San Francisco, Cal.; the company's galvanized steel electric transmission towers for high tension lines are in extensive use in this section, including such companies as the Pacific Gas & Electric Co., Southern California Edison Company, Utah Light & Power Co., etc. C. T. Clack is president; J. E. Jennings, vice president and Robert Grant, treasurer.

The Wolverine Tube Company, Detroit, Mich., with plant at Thirty-third street and McGraw avenue, has been acquired by new interests which plan for general plant expansion directly in line with the policy of the former organization. The company specializes in the production of seamless tube. Charles H. Limbocker is president.

The Weirton Steel Company, Weirton, W. Va., has awarded a contract to the McClintic-Marshall Company, Pittsburgh, Pa., for considerable structural material for its proposed new open-hearth steel plant and finishing mill at the existing works. The steel plant will comprise seven 100-ton open hearth furnaces and foundation work has been inaugurated. The output of the plant will be in the neighborhood of about 15 tons of material per day, which will be used entirely in the present hoop and band mills, hot and cold strip mills, and tinplate mills now a tthis location. A new 40-inch blooming mill will also be erected, and contract has been given to the Morgan Construction Company, Worcester, Mass., for a new 18 and 21-inch finishing mill for the production of sheet bars, billets, slabs, etc. The company has recently completed the construction of a 600-ton blast furnace, and this new unit will be placed in operation, it is expected, before the close of the summer. Plans are under way for three additional blast furnaces, one of which it is planned to build in the early future. The output of the first blast furnace will be used at the steel works.

With the acquisition of two blast furnaces of the Tonawanda Iron & Steel Co., North Tonawanda, N. Y., by the Donner Steel Company, Buffalo, the company has a total of four furnaces. This sale was recently perfected; the furnaces have been operated by the Donner company under lease and will be continued for the production of merchant iron. It is understood that a subsidiary organization will be formed at a later date to operate the acquired works. The plant, used primarily for forge, foundry and malleable iron has a capacity of about 180,000 tons per year.

The Dominion Steel Company, Sydney, N. S., has inaugurated construction work for a number of extensions to its plant, including the electrification of certain sections of the works. Two new electric power plants will be constructed, one for general operations at the steel plant, while the other will be located at the Wabana mine, from which ore for the steel plant is obtained. This latter structure will be an extension to the existing power plant at this location

The Youngstown Pressed Steel Company, Youngstown, O., has acquired a large tract of property at Warren, O., and plans for the early erection of a new plant. The new works will be used to centralize the present three plants operated by the company at East Youngstown, Haselton and Sharon. It will have a capacity considerable in excess of the existing combined capacity, with space to provide for such expansion as may be required in the future. With machinery and equipment it is estimated to cost about $1,000,000. The extension plans include the erection of a number of new hot mills at the Haselton works, operated as the Sharon Steel Hoop Company, it being planned to provide a total of 15 hot mills in all; a new machine shop will also be constructed at this location. The company specializes in the manufacture of pressed steel parts for automobile, truck, tractor and other production. The company was organized to take over and operate the pressed steel and fireproofing departments of the Youngstown Iron & Steel Co., as well as the channel and corner bead department of the Sharon Steel Hoop Company; W. W. Galbreath is president.

The Liberty Steel Company, Morristown, N. J., recently organized with a capital of $1,500,000 is making active progress in the establishment of its new local plant, which will be devoted, it is understood, to the manufacture of bars, sheets, plates, etc. The works will be located in a three-story building on Water street, recently leased for this purpose, while a new building is being erected for electric furnace department. A department will be arranged for the production of high-grade steel castings, to be substituted for forgings now used for different equipment manufacture. The organization is headed by Walter S. Rait, who will be in charge of operation.

BACK ISSUES.

The National Iron & Steel Publishing Co., 108 Smithfield street, Pittsburgh, Pa., will pay 15 cents per copy for all back issues of The Blast Furnace and Steel Plant.

Some Pointers on By-Product Coke Oven Operations

EQUIPMENT FOR CLAIRTON BY-PRODUCT COKE PLANT.

(Continued from Page 342)

stacks, one for each two boilers brick lined, 6' 6" I. D. 160' 0" high, one ash hoist operated with skip car; one ash gathering car, motor driven; one coke dust conveyor, 24" belt.

Fire Protection—One pump house; one three-stage centrifugal pump, 1,500,000 gallons capacity per 24 hours; 230 pound discharge pressure, 200 hp motor; four two-way fire plugs.

Drinking Water System—One deep well pump, 50,000 gallons capacity per 24 hours.

Power Transformer Station—One transformer station, 6,600 volts to 250 and 110 volts, for electric power and light required at benzol plant.

Office Building—One laboratory, office, police and sanitary station, combined, for benzol plant.

Water, Steam and Power Installations.

River Pump House—Three 24" Wilson Snyder horizontal centrifugal pumps, 20,000,000 gallons capacity per 24 hours, each; driven by 1,000 hp Westinghouse motor, 6,600 volts, 25 cycle, three-phase; one 15-ton electric traveling crane; one stand pipe, 24' 0" diameter 125' 0" high. Water requirements, 40,000,000 gallons per 24 hours.

Boiler House—Fourteen 600 hp Sterling boilers, equipped with Coxe stockers, superheaters and soot blowers; three steam turbine driven blowers; one feed water heater; cylindrical, for exhaust steam, 20,000 hp capacity; three steam driven duplex horizontal feed pumps, capacity 600 gallons per minute each; seven reinforced concrete stacks, one for each two boilers, brick lines, 6' 6" I. D., 160' 0" high; one ash hoist operated with skip car; one ash gathering car, motor driven; one coke dust conveyor, from breeze pit, 24" belt; one coke dust conveyor for distributing dust to bins on boilers, 24" belt.

Power House—Two 5,000 kw turbine driven, 6,600 volt, alternaters, 1,500 rmp, 25 cycle, three-phase, with barometric condensers; one 150 kw turbine driven exciter, 250 volts, 750 rpm, turbine speed 7,260 rpm, floating reduction gear; one 150 kw motor driven exciter, 250 volts, 750 rpm; one complete oil filtering syste mfor turbines; two air washings systems for generators; one 14 kw motor generator set for control circuits; three 200 kva power transformers, 6,600 volts, 220 volts; three 25 kva lighting transformers, 6,600 volts, 220 volts, 110 volts; one 30 ton electric traveling crane.

Switchboard Equipment — All oil and disconnecting switches and their conductors are enclosed in 84 foot brick cell structure; all switches are magnetically operated from a desk section, 24' 0" long, on the balcony. Average load of power house, 4,000 kw per hour. Total connected load of plant 16,000 hp.

Sub Station—Two 750 kw. two bearing, motor generator set, 6,600 volts ac, 250 volts dc; three 800 kva power transformers, 6,600 volts, 220 volts; three 25 kva lighting transformers, 6,600 volts, 220 volts; switchboard, 54' 0" long; distributing panels; concrete cell structure 28' 0" long.

Transformer Stations—Three transformer stations for ac current for coal hoist, coal conveyors, quenching pump motors.

Underground Conduits—All conductors are lead encased and are run underground in fiber conduit and in concrete. Sixty-five thousand feet of lead encased cable were required. Total capacity 5,500 kva.

Oil House—Building 25' 0" wide by 80' 0" long, for oil, grease and waste; four 12,000 gallon oil tanks, for engine, valve, carbon and black oil; six 1,000 gallon oil tanks, for turbine, compressor, motor, transformer and lard oil; four 170 gallon tanks for wood alcohol, turpentine, signal oil and linseed oil; one 550 gallon underground tank for motor benzol; 15 Bowser hand pumps; three waste bins, 600 pounds capacity.

Storeroom and Brick Shed—Building 54' 0" wide by 324' 0" long, fireproof; storeroom office, storeroom equipment with steel shelving.

Fire Protection (Coke Works)—One pump house; one three-stage centrifugal pump, 1,500,000 gallons capacity per 24 hours, 230 pounds discharge pressure, 200 hp motor; 12 two-way fire plugs.

Machine Shop—One brick building 102' 0" wide 220' 0" long, with two balconies; offices for master mechanic, superintendent electrical department; machine shop foreman. Equipment consists of the following:

One 30 ton electric traveling crane, one 42" engine lathe, one 24" engine lathe, one 20" engine lathe, one 14" engine lathe, one 12" engine lathe, two 24" crank shapers, one 20" crank shaper, one 120 ton hydraulic wheel press, one 60" gear cutter, one 48" openside planer, one 6' 0" boring mill, one locomotive repair pit, one 42" milling machine, one key way milling machine, one 6' 0" radial drill press, one 4' 0? radial drill press, one 25" drill press, one 21" drill press, one power cold saw, one hack saw, one key seater, two emery wheels, one two-stage air compressor.

Tool Room—One 28" milling machine, one 20" crank shaper, one 14" engine lathe, one tool cutter and grinding machine, one 21" drill press, one 12" emery wheel.

Blacksmith Shop—One 1,500 pound pneumatic forging hammer, three down draft forges, one heating furnace, one 4-ton jib crane.

Boiler Shop—One double punch and shear, two 2-ton jib cranes.

Office Building—One fireproof office and laboratory building, 52' 6" wide, 141' 2" long.

Telephone System—One complete telephone system with 60 stations.

Sanitary Stations—Eight complete sanitary stations, equipped with toilets, locker rooms, lockers, shower baths for all departments of plant.

Drinking Water System—Three deep well pumps, 50,000 gallon capacity each per 24 hours, for sanitary fountains throughout the plant.

Sewage Disposal Plant—One sewage disposal plant with sewage treating basins and separate sanitary sewer system.

River Wall—A concrete river wall is constructed along the harbor line the entire frontage of the first 12 battery unit. Wall 51' 0" high, 2,063 feet long, total concrete 45,000 cubic yards; base of wall 25' 0" wide with toe resting on wood piling 3' 0" centers driven to refusal.

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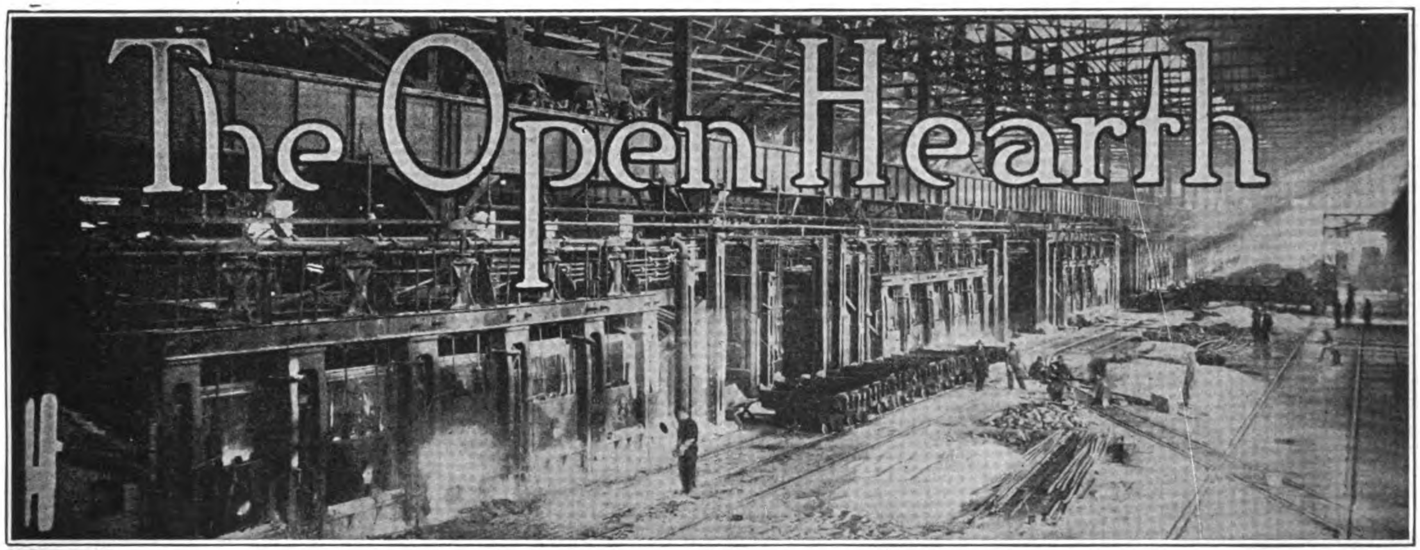


E. G. Grace, president of the Bethlehem Steel Corporation, has been elected a director of the Guaranty Trust Company, of New York.

V V

C. W. Engle, who has resigned as chief engineer of the Central Steel Company, Massillon, O

V V

John McConnell was elected vice president of the Interstate Iron & Steel Co., Chicago, at a recent meeting of the board of directors. Mr. McConnell has charge of the alloy steel production.

V V

T. L. Lewis, formerly general sales manager of the A. M. Byers Company, is now manager of sales of the Interstate Pipe Company, Pittsburgh.

V V

H. E. Copeland ns now chemical engineer with the Hill & Griffith Co., Chicago. He was previously chemist and metallurgical engineer for the Lenoir Car Works, Lenoir City, Tenn.

V V

John A. Guy, previously connected with the Ludlum Steel Company, Watervliet, N. Y., is now superintendent of the steel plant of the American Radiator Company, Buffalo, New York, in charge of the iron and steel foundry.

V V

T. B. Foust has taken active charge of the Clarkville Foundry & Machine Works, of which company he is president. He was previously superintendent of the furnace department of the Bon Air Coal & Iron Corporation, Lyles, Tenn.

V V

Charles J. Scott is vice president in charge of the scrap yard recently established in Coatesville, Pa., by Henry Potts & Co. Mr. Scott was at one time superintendent of the Valley and Viaduct mills of the Worth Brothers Co., and the Midvale Steel & Ordnance Co.

V V

R. J. Wysor is now assistant general manager of the Sparrows Point, Md., plant of the Bethlehem Steel Company, succeeding M. J. Scammell, recently resigned.

V V

J. A. Matthews, president of the Halcomb Steel Company, Syracuse, N. Y., recently sailed for Europe to study standardization of aircraft building in Europe. He is a member of the war department's aircraft standardization committee.

V V

O. D. Conover, formerly vice president and chief engineer of the T. W. Price Engineering Company has accepted the position of production and sales engineer on foundries and steel plants of the Austin Company, Cleveland.

V V

J. R. Allen has resigned as dean of the college of engineering, University of Minnesota, and is now director of the Research Bureau of the American Society of Heating and Ventilating Engineers, Pittsburgh.

Maj. F. H. Schoenfuss, formerly metallurgical expert with the United States ordnance department, has become associated with John H. Brewster, 30 East Forty-second street, New York, as American representative of the Fagersta Steel Company, Fagersta, Sweden.

V V

R. T. Harris, formerly connected with the open hearth plants of the Indiana Steel Company, Bethlehem Steel Company, and the Llewellyn Iron Works, has recently assumed the position of superintendent of the steel works of the Heppenstall Forge & Knife Co., Pittsburgh.

V V

Philip Wick has been elected vice president of the Ohio Iron & Steel Co., Youngstown, O., succeeding John C. Wick.

V V

John DeWolf is now associated with the Trumbull Steel Company, Warren, O., with headquarters in New York. He was formerly eastern sales representative with the Liberty Steel Company.

V V

W. M. Carty has accepted the position as superintendent of the Standard Brake Shoe & Foundry Company plant at Pine Bluff, Ark. He was formerly assistant superintendent of the American Brake Shoe Foundry Company, Chicago.

V V

D. E. Sawyer is now general manager of sales of the Pollak Steel Company, Cincinnati, O., with headquarters at 120 Broadway, New York. Mr. Sawyer was formerly connected with the Illinois Steel Company.

V V

Charles F. O'Hagan, formerly chief engineer of the Wm. B. Scaife & Sons Co., Pittsburgh, is now resident engineer and manager of the Chicago sales and engineering office, just established by that company at 38 South Dearborn street.

V V

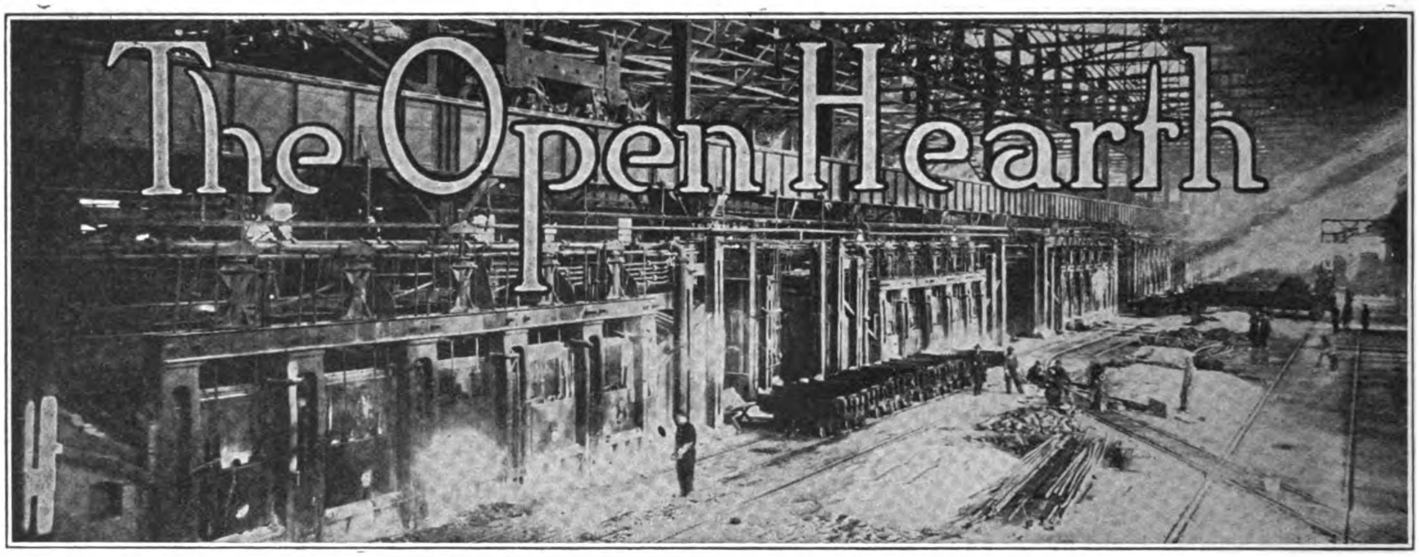
B. F. Faunce, superintendent of the forge and wheel department and L. R. Custer, superintendent of the armor plate department of the Homestead works of the Carnegie Steel Company, have resigned to accept similar positions with the Midvale Steel & Ordnance Co. L. J. Holman has been named to succeed Mr. Custer in the armor plate department, and Mr. Holman's place has been filled by Ralph Mills.

V V

Arthur M. Long has been promoted to be assistant general manager of sales of the Trumbull Steel Company, Warren, O., succeeding Paul Wick.

V V

Merrill G. Baker, who was appointed president of the American International Steel Corporation, 120 Broadway, New York, on April 1, has tendered his resignation, which takes immediate effect. No successor has been appointed, Morris Metcalf, vice president, being the executive now in charge. Mr. Baker's plans for the future have not been announced.



The Open Hearth

Charles L. Doyle has resumed his former activities of selling coal and coke, effective July 1, with headquarters in the Oliver building, Pittsburgh.

V V

Elliott H. Whitlock, consulting engineer of Cleveland, and formerly president of the Cleveland Engineering Society, has returned to this country with the rank of lieutenant-colonel after two years' service in France.

V V

William P. Mullane, formerly of Youngstown, O., has been made general manager of the Sligo Iron & Steel Co., at Connellsville, Pa., operated as a unit of the Federal Export Company, whose main offices are in New York. Mr. Mullane was advanced from superintendent.

V V

W. B. Wallis, vice president of the W. E. Moore & Co., consulting engineers, Pittsburgh, has sailed for Europe on a business trip relating to proposed installations of electric furnaces built under the Moore patents.

V V

J. H. Wilson has been appointed works manager of the Berger Manufacturing Company, Canton, O. He was formerly associated with the LaBelle Iron Works, American Rolling Mill Company and the United States Steel Corporation.

V V

L. J. Voyer has been elected secretary of the Ohio Corrugating Company, Warren, O., and appointed general sales manager. He succeeds W. P. Reed, resigned. Mr. Voyer was formerly manager of sales of the Liberty Steel Company.

V V

James E. Matthews, due to ill health, has resigned as manager of ordnance, Bethlehem Steel Company. Mr. Matthews acted in that capacity for nearly 20 years. He will be succeeded by G. W. Struble.

V V

H. A. Robinson, of the raw material department Midvale Steel & Ordnance Co., Philadelphia, has joined the sales staff of Park & Williams, Inc., Real Estate Trust Building, Philadelphia, dealer in pig iron, coke, ferroalloys, etc.

V V

The following officers of the Philadelphia Electric Steel Corporation, have resigned to join the Triangle Engineering & Equipment Co., Philadelphia: A. S. Breithaupt, assistant general manager; T. B. McCabe, superintendent; F. H. Shaw, assistant treasurer.

V V

Robert Bentley, president of the Ohio Iron & Steel Co., Youngstown, O., was recently elected vice president of the Youngstown Chamber of Commerce.

V V

Albert Mann recently resigned as purchasing agent of the Illinois Central Railroad, is now vice president of the American International Steel Corporation, New York.

Charles M. Schwab was presented with a solid gold medal at a special meeting of the citizens of Bethlehem, Pa., in recognition of his war services. The medal which is ⅛" thick and ¾" square illustrating the manufacture of steel in Bethlehem, was produced at a cost of more than $1,000.

V V

David W. Dunlevey has been appointed president of the Colonial Steel Company, Pittsburgh, succeeding John B. Finley, who died several months ago. Mr. Dunlevey has been identified with this organization since 1908, first as general superintendent and later as vice president in charge of manufacturing. Prior to that he was with the Crescent Steel Company, Pittsburgh, now a subsidiary of the Crucible Steel Company of America. The plant of the Braeburn Steel Company, Braeburn, Pa., was built under his supervision.

V V

George W. Scott has been appointed by the Stark Rolling Mill Company, Canton, O., district manager for the Chicago territory, with headquarters at 1119 Marquette Building. Mr. Scott has had a wide experience in sheets and fabricated products and was formerly Chicago representative of the Pittsburgh Steel Company. Thomas F. Murphy has been named district maanger for the Canton territory. Mr. Murphy was connected with the American Sheet & Tin Plate Co.

V V

Dan C. Swander, supervisor of sales of the Standard Parts Company, Cleveland, and J. G. Utz, supervisor of engineering, headquarters, both of whom are at the executive offices in Cleveland, have been promoted to vice presidencies. Both have been with the Standard Parts Company from its beginning. Mr. Utz was formerly director of engineering in the Perfection Spring Company and Mr. Swander was Eastern sales manager of the Firestone Tire & Rubber Co.

V V

William Bangser has resigned as manager of the American Electric Steel Company, York, Pa.

V V

J. I. Thompson, chief engineer, and A. W. Grant, Jr., gas engineer of the Koppers Company, Pittsburgh, sail for home from Christiana on July 3. Mr. Thompson and Mr. Grant have been studying by-product coke oven practises in France, Great Britain, Belgium and Sweden.

V V

Frank L. Estep, for several years chief engineer of the Tennessee Coal, Iron & Railroad Co., and later connected with the Nova Scotia Steel & Coal Co., Sydney, N. S., has been made a member of the firm of Perin & Marshall, 2 Rector street, New York.

V V

Jose M. Garmendia, sailed for Buenos Aires, June 28, to take charge of the iron, steel and machinery departments of the Federal Export Corporation in Argentina, under the direction of the general manager, George V. Guyer.

INDUSTRIAL RELATIONS

A BUSINESS MAN'S EXPERIENCE WITH INDUSTRIAL TRAINING.

By E. A. Barnes, General Electric Company, Fort Wayne, Ind.

Note—Here is a message of the greatest value for every manufacturer in America. It is from a representative of a firm which employs thousands; from a man who knows whereof he speaks. The war-emergency opened his eyes to the remarkable value of a training department such as was brought to his attention by the United States Training Service. At first it was temporary—for new employes. Then Mr. Barnes and his associates saw the wonderful possibilities of a permanent training department. In a direct and most interesting way Mr. Barnes tells, for the benefit of all who will read, just what his training department has done and what it proposes to do.—Charles T. Clayton, Director United States Training Service.

In almost every meeting of employers of labor the question which seems uppermost in the minds of factory managers, and which is almost sure to come up for discussion, is that of the enormous labor turnover in the last few years. Unquestionably this excessive turnover has been occasioned by unprecedented war demands for labor, which developed the practice of scalping and stealing labor from one community or plant by another throughout the country.

Reducing Turnover.

While this turnover is estimated to cost the employer from $25 to $100 per person, it is by no means the only loss in the factory that needs attention. The loss I have in mind is the loss due to the improper placing of men in the establishment and continuing, or attempting to continue, them in work for which they are not particularly fitted or in which they are not satisfied. It is obvious, I believe, that the correction of this latter condition will not only contribute to the general efficiency of the industrial plant, but will be a strong influence in reducing labor turnover.

Few industrial establishments have a real system of hiring, selecting, training, inspecting, and upgrading their help. In too many cases the old system of letting the shop foreman hire the men, without much consideration as to the applicants' ability and training, is still in effect, with the result that many of the new employes spoil work, ruin expensive machinery and tools, and really produce but little work that is perfect enough to be shipped. The "higher-ups" at such institutions, either through ignorance or fear, evince no interest in the working conditions of the men, but are satisfied to grumble and growl as a perfected system of bookkeeping brings enormous amounts of waste tickets to their attention month after month. The question, is the worker in the shop or office efficient, and, if not, why not? seems not to attract much attention. There are exceptions, however, to this general rule, for some few employers are now giving these questions the attention they merit.

First Step Toward Improvement.

A systematic investigation of general conditions certainly is the logical first step in improving conditions. It should be carried out by an experienced industrial engineer who should study the personnel of foremen, assistants, and operators, as well as the sequence of manufacturing operations. An investigation of this sort probably will uncover a great many shortcomings that the management either have been unaware of or so used to that they are not duly appreciated. But future industrial competition promises to be so keen as to make it imperative that all removable losses shall receive due attention. Therefore the company with which I am connected is giving a great deal of attention to the personnel of our plant and to the proper training and placing of the employes.

Specialized Training Courses.

We conduct specialized training courses which may be divided into three groups.

First, the school for the graduate engineer. Here we give the young technical-college graduates an extensive course through the shops, laboratories, and testing departments, supplemented by lectures on special subjects.

Second, the apprentice school for machinists and toolmakers. In this school selected applicants are given a short preliminary course to see if they are likely to develop into efficient workmen. Those who pass this preliminary course sign a contract for four years (the time required for the completion of the course), during which the men are given one and one-quarter hours' daily instruction in such subjects as drafting, methematics, and business English. The other hours of the day are spent at the machine or bench, where they are under the direction of experienced instructors. These apprentice students are paid a fair and graded rate during the entire time, and at the end of the course are given a bonus if they pass their school examinations, and still a second bonus if they pass their mechanical examinations. It takes no stretch of imagination to realize that men so trained in an atmosphere of intelligence and advancement can not fail to become the finest grade of high-class mechanics, foremen, and leaders.

Third, intensive specialized courses. We have also found it exceedingly profitable to give an intensive training course in drafting for women, who, on completion of the course, are transferred to regular drafting work in the engineering and drafting departments. Women clerks in the factory also are given the advantage of special courses in blue-print reading and factory routine, which familiarizes them with the product and systems to the extent that they can readily grasp situations and intelligently carry on the work.

In general, we are prepared to give to special classes of our employes intensive instruction in subjects pertaining to their daily work that a few years ago would have been thought wholly unnecessary.

Temporary Training Department.

Provision having been made for the training of the future engineers, special machinists, draftsmen, clerks, and future office executives it would seem that the training and upgrading of the man in the shop should be taken in hand and followed continuously and vigorously.

Our experience along this line extends over two years. When this country entered the war we were confronted with the common problem of obtaining adequate help to make up for the losses of young men entering the service, and were attracted by the bulletins put out by the United States Training Service concerning the vestibule school or training department. An investigation of some of the established schools developed the fact that they were in many respects similar to suggestions that we already had under consideration. We therefore decided to establish a real training department in which all classes of drill presses, grinders, engine lathes, turret lathes, and automatic screw machines would be installed, and where competent instructors would take applicants for employment and train them a sufficient length of time to guarantee their being productive when transferred to the factory. The rates to be paid the trained workers were attractive, and steady employment was insured.

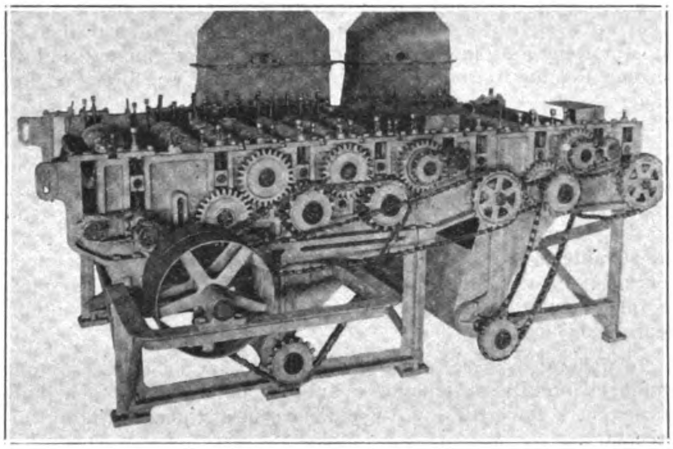
We ran this school, training operators for machine work with great success until the armistice was signed, when the necessity for it in its initial form naturally ceased to exist. The reports from the foremen and manufacturing engineers in the factory indicated that the employes who had been trained in this vestibule school were very efficient and desirable help; these trained operators were, in fact, much sought after and competed for by our various manufacturing departments. These facts lead us to the conclusion that the systematic training system is a good thing, and that it should be installed permanently.

WITH THE EQUIPMENT MANUFACTURERS

MACHINE FOR CLEANING TINPLATE.

An auxiliary cleaning machine for use as an attachment in connection with its standard cleaning machine for cleaning tinplate has been brought out by the Aetna Foundry & Machine Co., Warren, O. Several leading tin mills have been experimenting with these machines for some time with considerable success and the outfit has now been standardized.

As is well known, the tinplate as it leaves the oil bath has an uneven coating of oil in blotches. The function of the auxiliary is to remove the surplus oil and distribute the remainder in a thin even coating over the plate. For this preliminary cleaning process the old flannel disc rolls no longer serviceable in the main cleaners are entirely satisfactory in the auxiliary. Bran from the standard cleaner which would ordinarily be thrown out is made to serve a second time in the auxiliary and is used until thoroughly soaked. A highly polished clean plate not obtainable before is produced, and in addition the rolls and bran give double service which is a considerable item in reducing the cost of production.



Tinplate Cleaning Machine.

The auxiliary carries two sets of flannel disc rolls and a separate bran elevator. A special feature of this elevator is the use of two flight screws or worms. The upper worm carries the bran to the center of the machine and drops it in the center of the lower worm, which is a right and left-hand flight. In this way the bran works out from the center towards the housings and gives very good distribution.

The drive is from the regular cleaning machine through link chain. The photograph does not show the double worm feature as this has been added very recently.

LARGE WELD ON STERN FRAME.

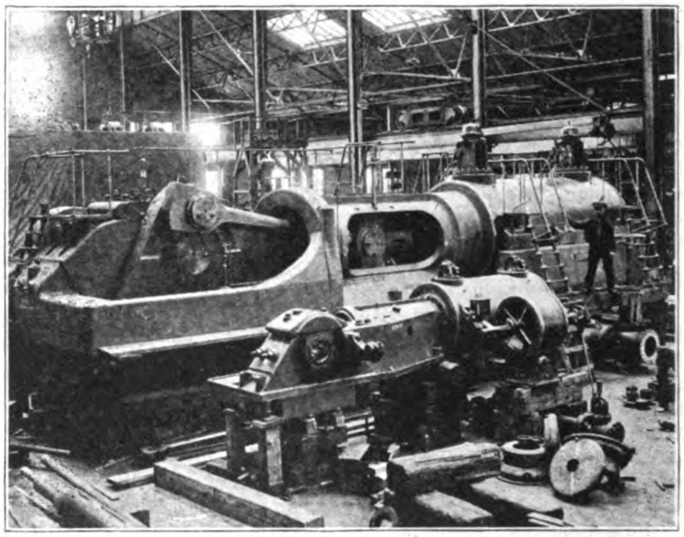
The Metal & Thermit Corporation, New York, has recently and successfully completed the largest marine weld ever recorded, on the cast steel stern frame of the huge United States Army transport, Northern Pacific. The section welded was entirely broken through as a result of the severe strain to which the frame was subjected when this transport, laden with homeward bound troops, ran aground on January 2, 1919, in a dense fog, off Fire Island, New York.

The stern frame was broken just above the upper rudder lug, in a position where the casting was hollow and measured almost two feet in diameter. The walls of the casting at this point measured about three inches thick.

The weld which required 1,400 pounds of thermit for the chemical production of the necessary amount of molten steel, and which was made without removing the casting from the ship, obviated the delay and expense which would have been entailed by the only alternative of purchasing an enormous new casting and installing it at a cost probably exceeding $50,000.

NEW TYPE OF NORDBERG ENGINE.

The distinguished position which B. V. Nordberg has attained as a designer of steam engines lends special interest to the announcement by the Nordberg Manufacturing Company of Milwaukee, Wis., of a new type of uniflow poppet valve engine.



Nordberg-Todd Uniflow Poppet Valve Engine.

The Nordberg company was the first to develop uniflow engines in this company, and the advantages of the uniflow type in maintaining high economy at underloads and overloads is well known.

The new Nordberg-Todd uniflow engine is built in sizes ranging from 200 to 2,000 hp for any available steam pressure, any available superheat, any available vacuum and any available back pressure. The assertion is made that under any of these conditions these engines will operate with lower steam consumption per horsepower, over wider variations of load, than any steam prime mover thus far developed.

Of special interest is the fact that the engine can be changed from condensing to non-condensing operation, or the reverse, while running.

THE CLARK TRUCTRACTOR.

The Clark Tructractor, manufactured by the Clark Tractor Company, Chicago, Ill., has proven itself to be a machine of exceptional merit. It is built of the very best quality material and is put together by efficient and highly experienced workmen and under the supervision of high grade engineers. It is built to stand up under the most severe industrial service.

It has been performing many important tasks in a number of large plants for the past year and a half, moving freight cars, heavily loaded trailers, and carrying loads up to a ton and a half constantly day after day without break-

WITH THE EQUIPMENT MANUFACTURERS

age or mechanical troubles. The fact that it operates on three gallons of gasoline, ordinary working day, makes it a most economical machine. Its power is inexhaustable and it has the same amount of strength and endurance, late in the afternoon as in the morning.

Its ability to run 24 hours a day without being laid up for recharging and its economical operation, coupled with the lack of breakage, make this machine an exceptionally efficient and satisfactory one for commercial purposes.

Having 9½ inches of ground clearance and an abundance of power, make it possible for the Clark Tructractor to manipulate rough ground, foundry floors, factory yards and bad roads. Sand and mud do not prevent this machine from successfully and quickly performing its duties under all weather and factory conditions.

Its great range of speed (from ¼ mile to 15 miles per hour) permit the Clark Tructractor to creep through congested places and around sharp corners, deliver its load exactly in the place desired without danger to machinery or employes and to run at high speed through open places and in the traffic of roads and city streets.

One of these machines was recently driven from Buchanan, Mich., to Chicago, Ill. This machine was stopped at several of the large industrial plants on the way, and most interesting demonstrations were held. It covered a distance of 143 miles in one day and arrived in Chicago in first class condition, ready to begin regular routine work in one of the well known institutions.

AUDIBLE ELECTRIC SIGNALS IN INDUSTRIAL PLANTS.

By V. Karapetoff,*

Professor of Electrical Engineering, Cornell University,
Ithaca, N. Y.

No industrial plant of any magnitude may be considered fully efficient unless means are provided for promptly locating any important employe, no matter where he may be within the plant. A privatec telephone system, however, extensive, serves this purpose only as long as the needed man is at his desk, but as soon as he leaves his desk the problem of locating him becomes a hit or miss proposition. On the other hand a superintendent, a forman, a millwright, a repair man, etc., is ordinarily useful only insofar as he can freely move about the shop without the fear that someone of importance may need him. Thus, within the last few years, under the tremendous impetus of the pressure for an enormous increase in the production of munitions of war, audible electric signals have been introduced into many industrial plants.

Such an electric signal is usually similar in construction to the familiar electric "horn" used on automobiles. It consists of a diaphragm with an anvil at its center. A toothed wheel driven by a small electric motor strikes the anvil many times a second and causes it to vibrate vigorously. These vibrations produce the well-known warning tone, which carries over a considerable distance. The device is provided with a projecter or horn the shape of which depends on whether it is desired to scatter the sound, to intensify it in horizontal direction, or to deflect it downward. Such motor driven signals are now made much more powerful than automobile horns, and are wound for 110 or 220 volts, direct or alternating current, so that they can be connected to a lighting or power circuit, and do not require a separate low-voltage battery.

With such electric audible signals scattered throughout the plant, it becomes an easy matter to locate instantly any person to whom a code number has been assigned. For example, when the manager wishes to speak to one of the assistant superintendents, who may be anywhere in the plant, he simply tells the telephone operator to sound this particular man's call. As soon as this assistant superintendent hears his call, he comes to the nearest telephone, and reports, whereupon the operator connects him with the manager.

It would be rather inconvenient for the telephone operator to sound various calls by hand; therefore a special code-calling automatic instrument has been developed for this purpose. The operator merely sets the desired person's code number on a dial and pulls a lever, a contact-making mechanism is thereby set in motion, which closes the electric circuit and operates the code signals throughout the plant the required number of times (usually three times) and then stops automatically.

In noisy and in open places, or in large factory lofts, the electric horns mentioned above constitute the most suitable type of signal. In offices they may be replaced by less loud electric gongs, bells, buzzers, air whistles, or incandescent lamps. In some cases two separate circuits are run from the code calling mechanism, one circuit for ordinary calls, the code calling mechanism, one circuit for ordinary calls, the other for fire-alarm gongs, or for some other special purpose. Sometimes two allied plants are operated side by side with a separate staff in each. Then the same code combinations can be assigned in both plants, but the horns in one or the other plant will sound according to which of the two circuits is closed.

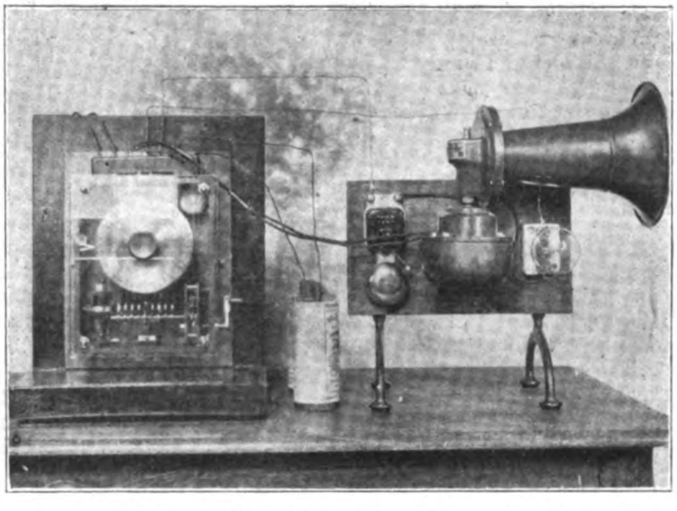


Fig. 1—A code calling instrument (Klaxocator), and the signals which it actuates viz., an electric horn, a bell and an electric lamp.

A further application of loud electric horns in industrial plants is for extensionsc to telephone bells. The ordinary telephone ringer is not loud enough in many shops when the foreman is away from his desk. In this case, a relay is connected in parallel with or in place of the telephone ringer, and when it is actuated, it closes a secondary circuit which causes an electric horn to sound. This call should be a single blast to distinguish it from code calls.

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*An extract from a paper presented before the Rochester, N. Y., section of the American Institute of Electrical Engineers, on April 25, 1919, and before the Erie, Pa., section on May 13, 1919.

Trade Notes

The Ohio Electric & Controller Co., 5900 Maurice avenue, Cleveland, O., announce they have appointed as their representatives, the following firms: The Iron & Steel Equipment Co., 1502 First National Bank Bldg., Pittsburgh, Pa.; Williams, Beasley Company, 343 South Dearborn street, Chicago, Ill.; Linn O. Morrow, 707 Franklin Trust Building, Philadelphia, Pa.; J. W. Dopp & Co., 18 Columbia street, Detroit, Mich.; Kelly, Powell Ltd., 403 McArthur Building, Winnipeg, Can.; Wonham, Bates & Goode, Inc., Dominion Express Building, Montreal, Can.; Shook & Fletcher Supply Co., Birmingham, Ala.

For export—Wonham, Bates & Goode, Inc., 7 Battery place, New York City, London, Paris, Havana, Rio de Janeiro; Mitsui & Co., 65 Broadway, New York, Japan, China, Philippine Islands, and Honolulu; Gustav Neilson, A/S Christiania, Norway, Sweden and Denmark.

The New York Testing Laboratories which have been organized by L. R. Seidell, G. B. Jack, Jr., and H. H. Geist, formerly chief metallurgist, assistant chief metallurgist and chief chemist respectively of the Wright-Martin Aircraft Corporation, have in addition to their well equipped laboratories at 354 Mulberry street, Newark, N. J., opened up their New York offices at 74-80 Washington street. In addition to chemical and physical testing and microphotography, this organization is specializing in the source inspection of materials, and as consultants in smelting, foundry, drop forging and heat-treating practices and the metallurgical investigation of shop troubles.

Edward F. Davis is now associated with the Celite Products Company. Mr. Davis has had wide experience in the gas engineering lines. He is specializing particularly in the application of Sil-O-Cel insulating products to the gas manufacturing and industrial gas equipment.

E. A. Hitchcock has recently become connected with the Bailey Meter Company of Cleveland, O., as vice president. He will supervise the training of technical graduates for the company's service and sales departments. During the past six years he has been connected with the E. W. Clark & Co. Management Corporation as advisory, consulting and power sales engineer. Previous to that time he was professor of experimental engineering at Ohio State University.

The Electric Furnace Construction Company, Finance Building, Philadelphia, reports the following orders received for Greaves-Etchells electric furnaces: Lancia Company, Turin; Bresciana Company, Brusche. They have also successfully started up new furnaces at the Daimler Motor Company, Coventry; at the Tyne Electric Steel Foundries, Ltd., and also a furnace for Kayser-Ellison & Co., Ltd., Sheffield, designed for up to 15 tons cold metal or 20 tons hot metal process.

Hamilton & Hansell, Inc., announce the sale of the following furnaces during the present month: One 1,000-lb Rennerfelt furnace, 400 KVA to the Steel Alloys Company of America, to be erected at their plant in Bayvay, Elizabeth, and which furnace will be used for the reduction of tungsten-acid to metallic tungsten. One 1,000-lb. Rennerfelt furnace, 200 KVA to the British American Nickel Company, Ottawa, Can., to be erected at their Deschene plant in Quebec, and which furnace will be used for melting nickel. One 150 KVA, single phase pot furnace with its complete equipment, sold to the government of the Netherlands, Colonial Department, and which furnace will be erected at their experimental station in Batavia, Java, Dutch East Indies.

An order has been placed with the Electric Furnace Construction Company, Finance Building, Philadelphia, for an electric furnace for the manufacture of ferro-alloys for Spain, by the Sociedad Espanola de Construccion Naval, the advisory committee of whom consist of the firms of Sir W. G. Armstrong Whitworth & Co., Vickers, Ltd., and John Brown & Co. This is the first furnace of its kind to be erected in Spain for converting their own natural ores into ferro-alloys."

The Pittsburgh office of the Niles-Bement-Pond Company has been moved from the Frick Building to 425 Seventh avenue. A stock of Pratt & Whitney small tools will be kept at this new office and store.

The Blaw-Knox Company announces the opening of an office in the Little Building, corner Boylston and Tremont streets, Boston, Mass., and in the Owen Building, Detroit, Mich. A. W. Ransome, formerly of the New York office, assumes the duties of New England manager. H. J. Desson has been transferred from the Pittsburgh office to Detroit to assume the duties of manager of the Michigan district.

The Pittsburgh office of the Whiting Foundry Equipment Company, 1224 Fulton Building, will be in charge of R. S. Hammond, beginning July 1, succeeding F. J. Page, former Pittsburgh representative.

The American Metallurgical Corporation who control and operate the Philadelphia Electrical Steel Corporation at Conshohocken, Pa., announce that John Gillespie has superseded Arthur S. Breithaupt as general superintendent of the above mentioned steel plant. Mr. Breithaupt having resigned from this position. Mr. Gillespie has been with the steel casting department of the Midvale Steel Corporation for 24 years, and is widely known in connection with the Eastern Steel Casting Fraternity. Plans are being prepared in connection with the proposed increased capacity of the plant which will be taken care of by additional electric furnace units.

The War Trade Board announces (W. T. B. R. 779) that applications will be considered for licenses to import into the United States from Germany or elsewhere scientific books and journals which were printed in Germany. Licenses covering such importations will not, however, be issued until the importer in the United States has made effective arrangements to make the purchase price of such books or journals available for the purchase of foodstuffs for Germany.

Trade Publications

The accurate measurement of gases and air has always presented difficulties because of variations in physical conditions under which they must be measured, variations in pressure, temperature, gravity, humidity, composition, etc., all having their effect on the accuracy of the results given by many kinds of gas and air meters. In an effort to acquaint those interested in the accurate measurement of gas with the direct results obtainable and the field of application of the Thomas Meter, the Cutler-Hammer Manufacturing Company of Milwaukee, has prepared a 16-page two-color 8½x11 booklet, entitled, "The Value of the Accurate Measurement of Gases and Air in Gas Plant, Coke Oven Plant, Steel Plant, Chemical Plant."

Engineers and operator of coke ovens and steel plants will be especially interested in pages 11 to 15, which are devoted to the measurement of coke oven, surplus and fuel gas, as well as the measurement of gas used by various steel mill departments. The Thomas Meter has been successfully employed for the measurement of gas to open hearth furnaces, soaking pits and boilers, as well as the fuel gas and surplus gas of coke ovens. Among the interesting illustrations and charts shown in this booklet, one of the latter illustrates two piping arrangements for the measurement of gas to open hearth furnaces. Another shows how surplus gas is measured by two Thomas Meters at a large coke plant in Ohio, and how after being distributed, it is again measured by other Thomas Meters at points of delivery to three large industrial plants and the boiler room of an electric generator station.

The booklet contains a reproduction of a section of a graphic chart taken from the Thomas Meter graphic instrument at a large coke and gas plant and illustrates the good uniform operation secured through the aid of the chart. Typical installation views show the Thomas Meter housing measuring coke oven fuel gas, surplus coke oven gas as supplied to six furnaces in a plate mill, and surplus gas sent out from the coke ovens at the Northampton Works of the Bethlehem Steel Company, to their steel mill at South Bethlehem, Pa.

The Whiting Foundry Equipment Company, have issued a new catalog No. 145, on "Whiting Railroad Equipment."

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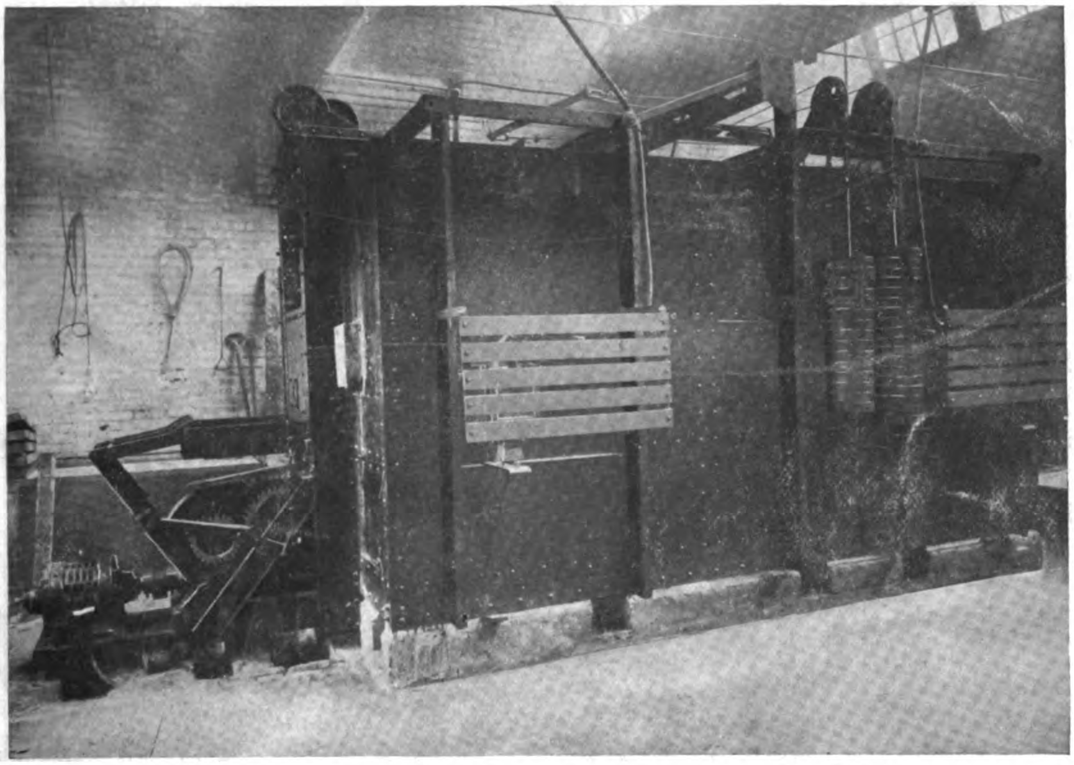
The Blast Furnace and Steel Plant

Pittsburgh, July, 1919.



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